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A COLLECTION OF MARINE NEMATODES FROM JAPAN[1)]

WOLFGANG WIESER
Zoological Institute, Lund, Sweden

With 10 Text-figures

Hitherto not more than 5 nematodes from Japanese waters have been known. STEINER & HÖPPLI (1926) described *Acanthopharynx japonicus*, *Croconema mamillatum*, *Euchromadora archaica* (= *E. loricata*) and *Dicriconema tenuis* from the shore of Joshi Island near Kobe, and in 1951 ALLGEN described *Leptosomatum abyssale* from the Sagami Sea in 400 fathoms depth.

On the East Asiatic mainland the situation is not much different since only one collection from Hoshiga Ura, near Port Arthur consisting of 6 species of nematodes is known (STEINER 1922). These 6 species are: *Phanoderma macrophallum*, *Eurystoma terricola* var. *ophthalmophora* (= *Eurystomina ornatum*), *Cyatholaimus asiaticus* (= *Acanthonchus gracilis*), *Monoposthia chinensis*, *Draconema cephalatum*, and *Siphonolaimus tenuis*. Thus one may conclude that the free-living marine nematodes of East Asia are almost unknown.

I am therefore much obliged to Dr. Takasi TOKIOKA of the Seto Marine Biological Laboratory for having sent to me a collection of nematodes which proved to contain 26 species, of which 21 could be determined. Of these, 4 species are new to science. Of the 11 species already known from East Asia, and mentioned above, only one, viz. *Eurystomina ornatum*, was present in the material. The locality in which the sample was collected is just below the Seto Marine Biological Laboratory, Shirahama-tyô, Wakayama-ken. This is far south of Osaka, on the western coast of Kii Peninsula near Siono-misaki, the southernmost cape of the peninsula.

The nematodes are derived from Sargassum spp. growing on the rocks below low water mark. The area is exposed to the open sea and the surface of the rocks is practically without sediments.

The following species were found:

Halalaimus sp.	2 ♀
Enoplus sp. 1	9 juv.
Enoplus sp. 2	1 juv.
Syringolaimus striaticaudatus DE MAN	1 ♂, 1 ♀, 1 juv.

1) Contributions from the Seto Marine Biological Laboratory, No. 252.

Oncholaimus dujardini DE MAN	1 ♂, 1 ♀, 3 juv.
Viscosia carnleyensis (DITLEVSEN)	1 ♂, 3 ♀, 3 juv.
Eurystomina ornatum (EBERTH)	9 ♂, 2 ♀, 4 juv.
Polygastrophora tenuicollis (ALLGEN)	3 juv.
Paracanthonchus hawaiiensis ALLGEN	1 ♀, 1 juv.
Acanthonchus setoi nov. spec.	1 ♂, 1 ♀
Halichoanolaimus robustus (BASTIAN)	1 juv.
Desmodora scaldensis DE MAN	2 ♀, 2 juv.
Chromadora macrolaimoides STEINER	2 ♂, 1 ♀, 3 juv.
Chromadora brevipapillata MICOLETZKY	1 ♀.
Chromadora nudicapitata BASTIAN	20 ♂, 28 ♀, 7 juv.
Chromadorina inversa nov. spec.	1 ♀.
Chromadorella filiformis (BASTIAN)	3 ♂, 3 ♀
Euchromadora Tokiokai nov. spec.	6 ♂, 5 ♀, 6 juv.
Euchromadora amokurae (DITLEVSEN)	1 juv.
Neochromadora craspedota (STEINER)	1 ♂, 1 ♀
Spilophorella tollenifera nov. spec.	7 ♀, 7 ♀
Spilophorella paradoxa (DE MAN)	1 ♀
Chromadoropsis parva (DE MAN)	3 ♂, 3 ♀
Linhomoeus sp.	1 ?
Paramonhystera paranormandica (MICOLETZKY)	1 ♀
Monhystera sp.	1 ♂, 2 ♀
Total of specimens	167

Taxonomic Notes

The scale in the following figures represents, if not stated otherwise, 10 μ.

Family Ironidae

Syringolaimus striaticaudatus DE MAN 1888

Syn.: *S. smarigdus* COBB.

1 ♂, 1 ♀, 1 juv.

The species is cosmopolitan. Amongst other places it was found in great numbers around the Sunda Islands (MICOL. & KREIS 1930).

Family Oncholaimidae

Oncholaimus dujardini DE MAN 1878

1 ♂, 1 ♀, 3 juv. For synonyms see WIESER 1953.

♂:	L = 2.67	a = 53.5	b = 6.3	c = 46.3	
♀:	2.88	50.0	6.8	35.8	Vu = 73.4%

The specimens are typical save for the position of the excretory pore which lies nearer to the anterior end than hitherto described. In the female it is situated immediately behind the buccal cavity and in the male 1.4 stomatal lengths behind the anterior end (as against 2–2.4 stomatal lengths in my Chilean specimens). STEINER (1915) reported a specimen from Sumatra with the excretory pore at a distance of 3 stomatal lengths behind the anterior end. Thus it seems that the position of the excretory pore is subject to great variation; it cannot be used as a basis for specific or subspecific distinction in this species.

Cosmopolitan (Atlantic, Mediterranean, Black Sea, Pacific).

Viscosia carnleyensis (DITLEVSEN 1921a)

1 ♂, 3 ♀, 3 juv.

Cf. WIESER 1953.

♂ :	L = 1.45	a = 41.8	b = 5.5	C = 7.5	
♀ :	1.53	36.4	5.3	7.3	Vu = 47.5%

The tail in the female measures 9 anal diameters.

Distribution: Auckland Islands, Sunda Islands, Chilean coast.

Family Enchelidiidae

Subfamily Eurystomininae

Eurystomina ornatum (EBERTH 1863)

(Fig. 1)

Syn. *E. tenue* MARION 1870
E. assimilis (DE MAN 1878)
E. filiformis DE MAN 1888
E. ophthalmophora STEINER 1922

It should be stressed again (cf. WIESER 1953, p. 136) that STEKHOVEN's criticism of the taxonomic treatment of this species by MICOLETZKY (1924a) is not justified. The relative length of the spicula varies not only individually, but also according to their position, that is to say, the spicula appear to be longer if they are withdrawn and the distal end covered by the heavily cuticularized accessory pieces. Moreover, EBERTH's figures are not exact enough to permit them to be taken as a basis of comparison in more subtle questions.

The present specimens make it clear beyond all doubt that STEINER's *E. terricola* var. *ophthalmophora* is also synonymous with *E. ornatum* (compare the present figure with those of STEINER 1922 and FILIPJEV 1918).

Thus the group B–2–b–aa in the key of my previous paper (1953, p. 136) contains only *E. ornatum* and *E. ornatum* var. *indicum* MICOL. & KREIS. However, the status of this latter species is doubtful too. It might be synonymous with *E. eurylaima*

(DITL.) The taxonomic value of the lacking wings of the supplement in males is not quite clear. In one specimen of my *E. ornatum* these wings were also absent which shows that their presence or absence is not always a reliable species character.

9 ♂, 2 ♀, 4 juv.

juv.:	L = 2.90	a = 68.7	b = 5.7	c = 29.1	
♂1:	3.34	87.0	6.7	29.0	
♂2:	4.03	88.0	6.6	31.0	Vu = 55.6%
♀1:	3.87	66.6	6.1	33.7	55.8

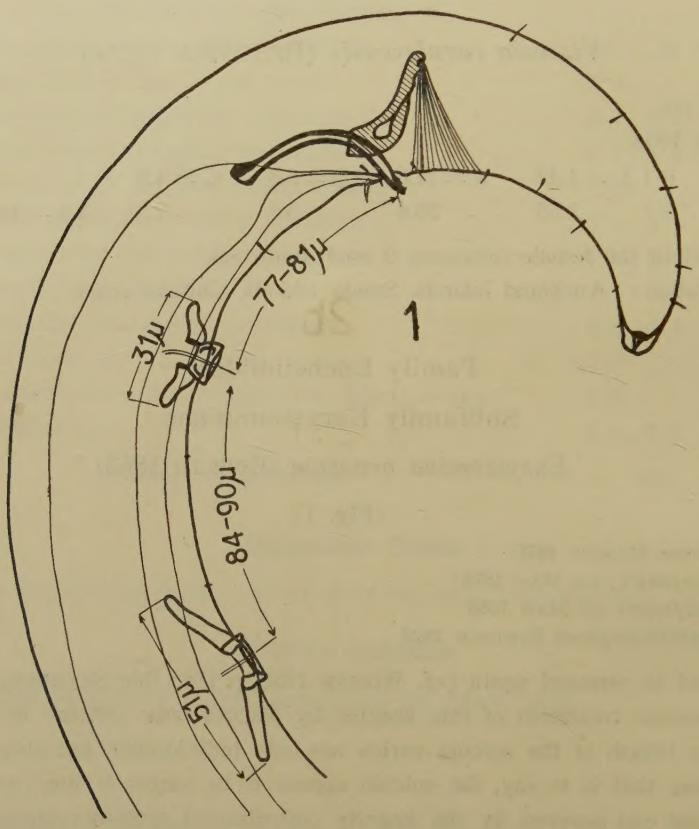


Fig. 1. *Eurystomina ornatum* (EBERTH). Posterior end of male.

Head diameter 20.5 µ. Cephalic setae 11×5.5 µ long. Buccal cavity 22×13 µ. There are two and a half rows of denticles between the anterior and posterior chamber of the buccal cavity (just as figured by STEINER for *E. ophthalmophora*). Ocelli 36 µ behind anterior end. Cervical setae about 5 µ = 18% of the corresponding body diameter in length. Male genital apparatus exactly as figured by FILIPJEV 1918 for *E. assimilis*. I especially want to direct the attention to the minute cusps or

teeth at the distal end of the spicula which can be seen in FILIPJEV's figures 29 c, d and in my present figure 1. Length of spicula 50–54 μ = 40–50% of length of tail. Apophysis of accessory piece 31 μ long. The dimensions of the two supplements and their distance from the anus can be taken from figure 1. As already mentioned the alae of the supplements were absent in one specimen.

Length of tail 2.6, anal diameters in male, 3.0 in female, and 3.5 in juveniles.

Distribution: Atlantic, Mediterranean, Black Sea, Arctic Sea, East Asia (Hoshiga Ura). Hawaii and California are doubtful (ALLGEN 1947, 1951).

Subfamily Enchelidiinae

Polygastrophora tenuicollis (ALLGEN 1951) aff.

(Fig. 2 a–c)

3 juv.

juv. 1:	L = 0.88	a = 23.0	b = 2.1	c = ?
juv. 2:	1.14	43.8	3.0	11.0

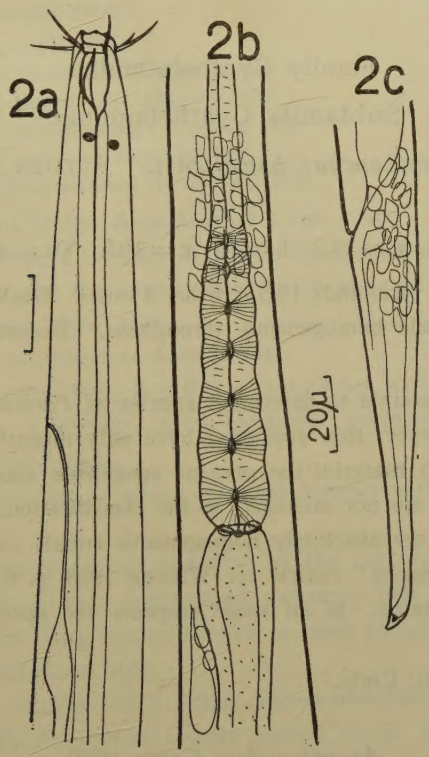


Fig. 2. *Polygastrophora tenuicollis* (ALLGEN). a, Anterior end; b, region of pharyngeal bulb; c, tail. All juveniles.

Cephalic diameter 6.5 μ. Cephalic setae about 7.5 and 3.5 μ long. Body diameter 6.5 μ. Cephalic setae about 7.5 and 3.5 μ long. Body diameter at end of pharynx 32 μ. "Ocelli" 14 μ behind anterior end. Buccal cavity 9 μ long, typical shape with one acute dorsal tooth and several projections; two transverse rings in the anterior portion. Excretory pore in the smaller specimen 52 μ behind anterior end, ampulla 77 μ. In the longer specimen the ampulla is 50 μ behind the anterior end. That is to say, the distal portion of the excretory apparatus moves forwards with each moult, a phenomenon quite usual in this family. Pharynx with 7 bulbi. These bulbi were quite distinct in one specimen, less so in another. The intestine is weakly developed. Tail 5 anal diameters long.

ALLGEN's description is too inexact to establish beyond doubt the specific identity of his specimens and mine. Moreover, ALLGEN had only females and I only juveniles at hand. However, none of the important characters of the species contradicts ALLGEN's description save that in the latter no cephalic setae are mentioned or figured; but since in ALLGEN's last papers cephalic setae in general are only of sporadic occurrence this difference should not be taken too seriously.

The species has been reported from Hawaii.

Family Cyatholaimidae

Subfamily Cyatholaiminae

Paracanthonchus hawaiiensis ALLGEN 1951

1 ♀, 1 juv.

♀: L = 1.20 a = 24.2 b = 70 c = 10.5 Vu = 47.0%

Head diameter 25 μ. Amphids 10.5 μ wide, 4 turns. Ocelli 44 μ behind anterior end. Tooth small. Cuticle homogeneous throughout. Excretory pore apparently in front of ocelli.

In general it is not possible to determine species of *Paracanthonchus* on the basis of females alone. However, this species I have only recently described from Chile (WIESER 1954) to which material the present specimens show such a striking resemblance that I think I am not mistaken in the classification. The most important characters are the ocelli, the absolutely homogeneous cuticle (as to the terms "homogeneous" and "heterogeneous" cuticle see WIESER 1953, p. 6), the very small tooth and the amphids with 4 turns. In all these respects the specimens from Chile and Japan completely agree.

Distribution: Hawaii, Chile.

Acanthonchus COBB 1920

A comparison between the description of COBB and of DITLEVSEN (1921b) shows

that the two genera *Acanthonchus* and *Seuratiella* are distinguished only by the presence or absence of a dorsal tooth. This is a character of no taxonomic value in the closely related genus *Paracanthonchus* (see WIESER 1954), for which reason it seems illogical to ascribe to it more than subgeneric importance in the present genus. Even that might be too much in the light of future knowledge and the two genera might prove to be synonymous. However, for the time being I maintain the subgeneric status for them. A key to the species reads as follows:

A) Tooth absent. 4 tubular supplements in male of which only the anterior is much bigger than the others.

Subg. *Seuratiella* (DITLEVSEN 1921b)

(Note: ALLGEN claimed in 1933 that the type—and only—species of this subgenus, *A. gracilis*, is provided with a tooth. This opinion is contradicted not only by two different fairly clear descriptions of DITLEVSEN (1919, 1921b), but also by a quite excellent description of STEINER, since there is no doubt that *A. asiaticus* (STEINER 1922) is synonymous with *A. gracilis*. In the light of these three independent investigations there is no possibility of defending ALLGEN's view and we must presume the latter was dealing with another species.)

A. gracilis (DITLEVSEN 1919)

Syn. *Seuratia gracilis* DITL.
Seuratiella pellucida DITLEVSEN 1921b
Cyatholaimus ampulaceus ALLGEN 1929
Cyatholaimus microdentatus ALLGEN 1929
Cyatholaimus asiaticus STEINER 1922
?*Chromadora problematica* DITLEVSEN 1919

B) Large tooth present. Subg. *Acanthonchus* COBB s. str.

1) 4 tubular supplements in male of which the second anterior is larger than the 2 posterior ones, and the anteriormost twice as large as the second.

A. viviparus COBB 1920 (type)

Syn. *Seuratiella pedroensis* ALLGEN 1947

A. duplex (ALLGEN 1947) is either synonymous with the species above or distinguished by a distally more expanded accessory piece. The species is insufficiently described.

2) 5 preanal supplements of which only the anteriormost is much bigger than the others.

a) Amphids approximately one-third of the corresponding body diameter in width. The anterior supplement measures half the body diameter at its level. 3 very long postanal setae in male present.

A. cobbi CHITWOOD 1951

A. arcuatus (KREIS 1926): Syn. *Paracanthonchus arcuatus*, is either synonymous with *A. cobbi* or closely related to it. There are some structural differences in the male genital apparatus; the amphids seem to describe fewer turns and the postanal setae are not mentioned.

b) Amphids in male measuring 65% of the corresponding body diameter. Anteriormost supplement as long as the body diameter at its level. Postanal setae relatively short.
A. setoi n. sp.

A. californicus (ALLGEN 1947)
Syn. *Seuratiella californicus*, is a species inquirenda.

Acanthonchus (*Acanthonchus*) *setoi* n. sp.

(Fig. 3 a, b)

1 ♂, 1 ♀

♂: L = 1.22 a = 36.0 b = 6.3 c = 12.0

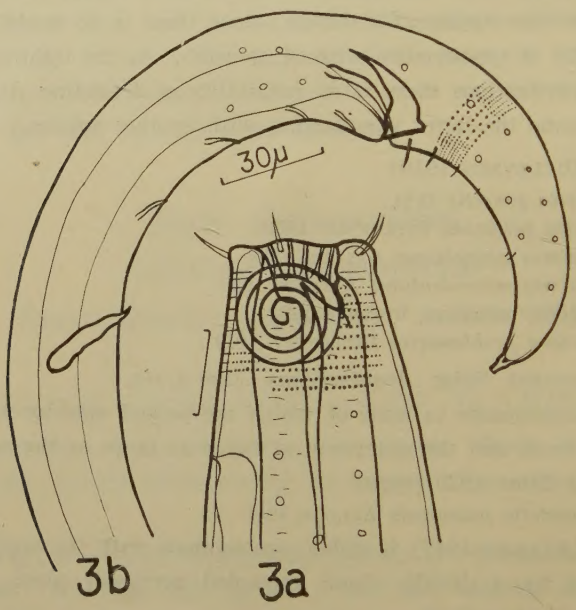


Fig. 3. *Acanthonchus setoi* n. sp.
a, Anterior end of male; b, posterior end of male.

Head diameter 17μ. Cephalic setae measuring about one-third of the head diameter. Amphids very big in male, 12.2 μ = 65% of the corresponding diameter in width, describing somewhat more than 4 turns (it might be situated farther back than shown in fig. 3a, since my single male was slightly curved in the slide). Excretory pore 1.3 head diameters behind anterior end. Buccal cavity very deep, armed with a big dorsal tooth. Cuticle homogenous in most parts of the body, heterogeneous on the tail. Pores numerous. Spicula length 26 μ = 0.8 anal diameters, slightly cephalate proximally. Accessory piece double, 27 μ long, distally 10.5 μ wide and

serrated. 5 preanal supplements present, the anteriormost of which measures 30 μ, that is about as much as the body diameter at its level. The distance between the anteriormost supplement and the anus is 120 μ.

Postanal setae present, not unusually long.

Male tail 3 anal diameters long.

The female was damaged and consequently no complementary data can be supplied.

Subfamily Choanolaiminae

Halichoanolaimus robustus (BASTIAN 1865)

1 juv. Apparently typical. Cephalic setae 4 μ long, that is about one-eighth of the cephalic diameter. Amphids describing 3.5 turns, measuring one-fourth of the corresponding diameter in width.

Distribution: Baltic, North Sea (Kola Fjord, Murman), Mediterranean, Black Sea. According to ALLGEN (1948, 1951) also in California.

Family Desmodoridae

Desmodora scaldensis DE MAN 1889

(Fig. 4)

Syn. *D. paramicrochaeta* ALLGEN 1947

2 ♀, 2 juv.

♀ 1:	L = 0.85	a = 21.3	b = 6.6	c = 10.1	Vu = 57.1%
♀ 2:	1.19	31.8	5.4	14.0	?

My specimens are typical and prove what I presumed already in my treatment of the Chilean nematodes (1954) that *D. paramicrochaeta* ALLGEN is synonymous with *D. scaldensis*. Further, *D. aucklandiae* DITL. is very closely related, perhaps even synonymous, although in the absence of males this cannot be decided.

Head diameter 16μ. Cephalic setae 7μ long. Amphids 7μ = 37% of corresponding diameter in width. The tooth is slightly larger than figured by DE MAN. Tail 3.2 anal diameters long, conical.

Distribution: North Sea, Arctic (Relic Lake Mogilnoje, SAVELJEV 1912), Hawaii, California.

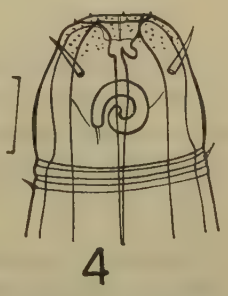


Fig. 4. *Desmodora scaldensis* DE MAN. Anterior end of female.

Family Chromadoridae

Chromadora BASTIAN

The taxonomy of this genus is still unsettled. A large material from the Mediterranean which I had the opportunity to examine since I finished my monograph on the Chilean nematodes makes it clear that the key which I gave in this previous account (1954) has to be changed again in some important points. The taxonomic value of the micropapilla right in front of the male anus, and the shape of the pharyngeal bulb, have especially to be re-considered. It seems that the species *C. nudicapitata* is polymorphic and includes many more synonyms than hitherto assumed. The recognition of races will be possible in the future, but has to be based on a detailed quantitative study of the pertaining characters.

For this reason a new discussion of the genus would only be premature and I shall confine myself to a comparative representation of the three species found (Figs. 5–7).

However, I am able to establish one important distinction within the most difficult group 2 of my previous key. The species *C. macrolaimoides* and the closely related species *C. brevipapillata* are distinguished from all other species of this group by the following characters: Teeth very strong (compare figs. 5a and 6a with 7a!); spinneret in females long, distal end ventrally bent; preanal papillae in males weak, not protruding and of a structure which differs slightly from that in other species; spicula with the proximal portion shorter than the distal one; accessory piece without the lateral plates (cf. CHITWOOD 1951 and my own figure of the male of *C. brevipapillata* from the Mediterranean). These differences are very obvious for the experienced observer and allow even females to be separated. In the future it will perhaps be possible to establish a distinct subgenus for the species in question.

Chromadora macrolaimoides STEINER 1915

(Fig. 5 a–c)

For synonyms and discussion see WIESER 1954. The slender tail is a valuable character in separating this species from the closely related *C. brevipapillata*, but not from the more distant species *C. nudicapitata*. In this case the length and shape of the spinneret and the shape of the teeth are of higher importance.

2 ♂, 1 ♀, 3 juv.

CHITWOOD's recent description (1951) and my accompanying figures 5 a–c should suffice to recognize this species. However, my specimens differ from CHITWOOD's and STEINER's in that they have longer cephalic setae. These measure 11μ in the female with a head diameter of 12.5μ. The taxonomic value of this difference cannot yet be decided.

The teeth are very stout, especially the dorsal one. The bulb is oval, sometimes it is double, sometimes not. Tail in female 5.8 anal diameters long, in males 5.2. Spinneret 10μ long, distally bent. The spicula are exactly as CHITWOOD figures them ; the ventral projection in their proximal portion is especially noteworthy. The accessory piece is enlarged distally as in the other species of *Chromadora* (this is figured by STEINER but not by CHITWOOD), but they lack the lateral plates. Two weak preanal supplements are present in the position as figured by STEINER and CHITWOOD. Once more I want to stress that both spicula and supplements are of a shape different from that of other species of *Chromadora* (except *C. brevipapillata*).

Distribution: Mediterranean, Sumatra, British West Indies (Lesser Antilles), Gulf of Mexico.

Chromadora brevipapillata MICOLETZKY

(Fig. 6 a–c)

1 ♀

♀ : L = 0.76 a = 21.8 b = 5.6 c = 7.6 Vu = 50.0%

Of this species I have found both males and females in the collection of nematodes from the Mediterranean mentioned earlier. Since I shall give a detailed description, especially of the male, in a later publication the following short notes and the accompanying figures may suffice here. The species belongs to the same group as *C. macrolaimoides*, but is distinguished from the latter by the shorter cephalic setae (according to my own material), the shorter and plumper tail, and the more roundish pharyngeal bulb. Head diameter 13.5μ. Cephalic setae 9μ long. Bulb roundish. Amphids loop-shaped (as in other species of *Chromadora*). Tail 4 anal diameters long. Spinneret measuring 9μ, ventrally bent. Other characters as in *C. macrolaimoides*.

Known from the Mediterranean.

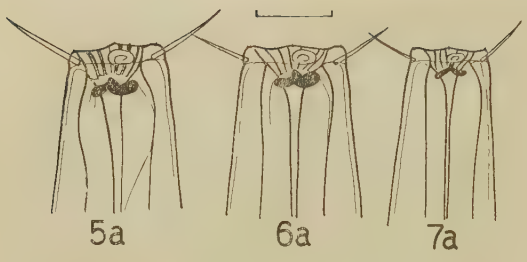
Chromadora nudicapitata BASTIAN 1865

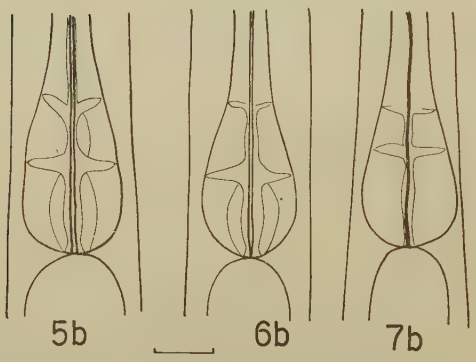
(Fig. 7 a–d)

Syn. *C. natans* BASTIAN
C. quadrilinea FILIPJEV
C. trilinea PARAMONOW
C. quadrilineoides CHITWOOD
Other synonyms are possible.

20 ♂, 28 ♀, 7 juv.

It is unnecessary to give a detailed description of this well known species. All the important data can be inferred from the figures. The shape of the pharyngeal bulb varies somewhat. The tail is slender and provided with a short spinneret (especially in females). The teeth are more slender and smaller than in the two foregoing species.





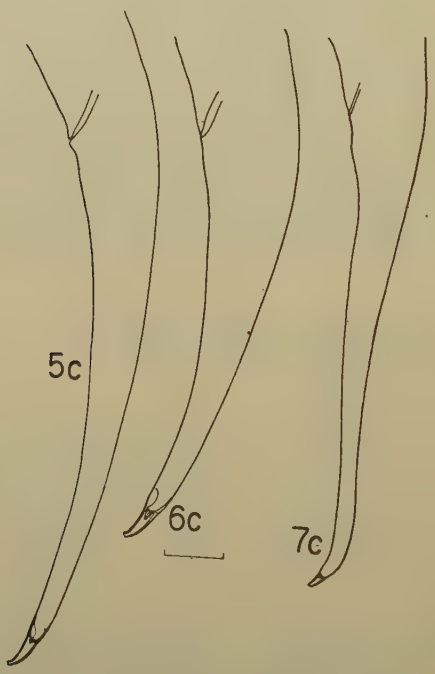


Fig. 5c. *Chromadora macrolaimoides* STEINER.
Fig. 6c. *Chromadora brevipapillata* MICOLETZKY.
Fig. 7c. *Chromadora nudicapitata* BASTIAN.
All tail of female.

Fig. 5. *Chromadora macrolaimoides* STEINER. a, Anterior end; b, pharyngeal bulb.
Fig. 6. *Chromadora brevipapillata* MICOLETZKY. a, Anterior end; b, pharyngeal bulb.
Fig. 7. *Chromadora nudicapitata* BASTIAN. a, Anterior end; b, pharyngeal bulb.

Fig. 7d. *Chromadora nudicapitata* BASTIAN.
Tail of male.

All the males were equipped with three large papillae and one micropapilla immediately in front of the anus. Studies on Mediterranean chromadorids have convinced me that the absence or presence of this micropapilla is due to individual variation; at least in the Mediterranean material, which was derived from one single locality (Piraeus, Greece), the micropapilla was present or absent in specimens which certainly have to be referred to one single species. The Japanese population, on the contrary, is very homogeneous and the micropapilla is present in all males. How this different behaviour of the two populations can be explained I do not know. The recognition of races is quite possible. On the other hand, the distribution of papillae characteristic of the Japanese population, i.e. 3+1, was also met with in Greece, though very rarely. It is impossible to establish a race or subspecies on the distribution of papillae in one population if this same pattern of distribution occurs in a second population mixed with other patterns (as 4+1, or 5, or 6).

Typical for the present species is a postanal papilla in the middle of the male tail and a second one near the end of the tail. Both these papillae, particularly the latter, can be very inconspicuous and have, I am sure, been overlooked many times. In fact, as far as I can see, the distal papilla was never described before.

Distribution: One of the most widely distributed species of marine nematodes. It was found wherever nematodes were collected from seaweeds.

Chromadorina inversa n. sp.

1 ♀

♀: L = 0.49 a = 20.0 b = 5.3 c = 4.7 Vu = ?

Head diameter 10.5 μ. Cephalic setae 5.5 μ long. Bulb roundish. Tail slender, 7 anal diameters long.

My single specimen agrees fully with material I have found in the Mediterranean, and of which I shall give a detailed description later on.

Distribution: Mediterranean.

Chromadorella filiformis (BASTIAN 1865)

Syn. *Dichromadora tenuicauda* STEKHOVEN 1950
? *Chromadorella filiformoides* CHITWOOD 1951

3 ♂, 1 ♀

♂: L = 1.23 a = 35.6 b = 9.1 c = 8.0
♀: 1.08 23.5 7.1 7.9 Vu = 49.8%

Since I possess a large collection of the closely related *C. membranata* MICOL. from the Mediterranean I can now state with certainty that *C. filiformis* and the latter species are well distinguished. *C. membranata* possesses a lateral membrane, *C.*

filiformis does not. In *C. membranata* the lateral rows of dots in the cervical region are one-twelfth of the corresponding diameter apart, in *C. filiformis* one-eighth.

CHITWOOD mentions as the only distinguishing character between *C. filiformis* and his *C. filiformoides* the absence of ocelli in the latter. I do not know whether this suffices to keep the two species separate since in chromadorids the ocellar pigment is easily resolved by preserving fluids.

Head diameter 17μ. Cephalic setae 9μ long. Distance of lateral rows of dots from each other: 2.5μ in the cervical region (one-eighth of corresponding body diameter), 3.8μ in the mid-body (one-tenth), 3.5μ in the anal region (one-seventh).

Spicula 25μ long. Tail 5.6 anal diameters long. 5 supplements in the typical arrangement.

Distribution: North Sea, Atlantic, Mediterranean, Sargasso Sea, Sumatra, Australia, Hawaii, California; Gulf of Mexico?

Euchromadora DE MAN

In my previous treatment of this genus (WIESER 1954) I distinguished between two main groups of species, viz. one with powerful, the other with weakly developed buccal armature. Within the first group a further distinction can be made in species with an oval, well-defined bulb, and those in which the pharynx is gradually enlarging without forming a true bulb. This was also independently recognized by BRUNETTI (1951). The new species described below belongs to the group with gradually enlarging pharynx and symmetrical spicula. Three species were hitherto known which are not easily separated due to our incomplete knowledge of *E. africana*. Without males determination is as yet impossible. The two old species *E. striata* and *E. africana* form one group in which the accessory pieces are half as long as the spicula. The new species, *E. Tokiokai*, and *E. permutabilis* WIESER 1954 belong to a second group in which the accessory pieces are two-thirds as long as the spicula. The differences between the four species in question are set out in the following table:

	striata	*africana*	*permutabilis*	*Tokiokai*
Accessory pieces in % of spicula	50		66	
Length of spicula	70–90μ	44–48μ	104–133μ	41–50μ
Length of female tail in anal diameters	5–6	7.5–9	3.5–4	4.3–5.6
Length of female (mm)	1.6–2.1	1.6–2.2	2.0–3.1	1.0–1.7

I should like to emphasize that it is indispensable for exact classification of species of *Euchromadora* to give measurements in μ of the male genital apparatus.

Euchromadora Tokiokai n. sp.

(Fig. 8 a–c)

6 ♂, 5 ♀, 6 juv.

♂ : L = 0.95–1.55 a = 22.0–28.3 b = 5.1–6.0 c = 7.0–9.0

♀ : 1.03–1.69 20.0–24.5 5.0–5.5 7.6–8.8 Vu = 50.0–52.3%

(It is possible that in the above measurements last larval stages are also included—especially so in the males).

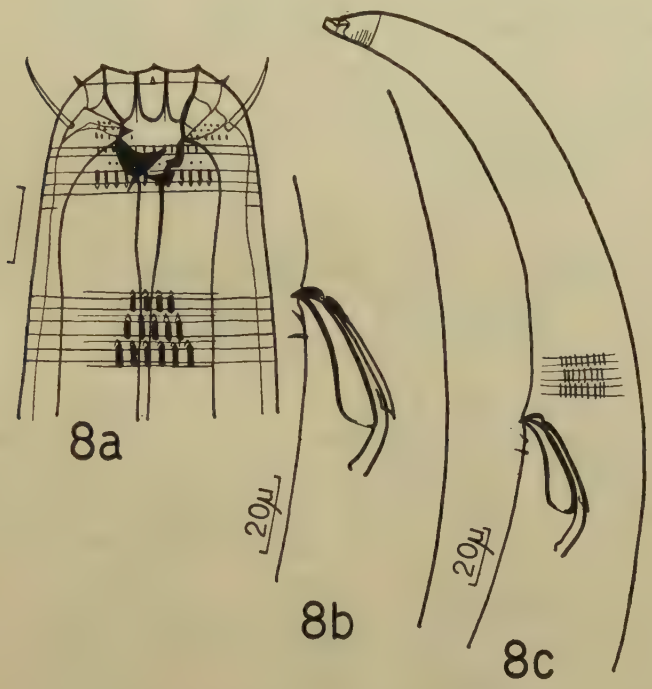


Fig. 8. *Euchromadora Tokiokai* n. sp.
a, Head of male; b, male genital apparatus;
c, posterior region of male.

Head diameter 25–26μ. Cephalic setae 10–11μ long. Body diameter at end of pharynx 37μ. 6 labial papillae and 6 setose cephalic papillae present. Buccal armature and cuticle without special features. The latter is not differentiated laterally, not even in the anal region of the male.

Spicula 41–50μ long, without velum; proximal end with a slight ventral projection. Gubernacle 30–35μ long, lateral pieces dilated proximally and truncate. There are the usual two preanal setae. Tail in male 4.3–4.5 anal diameters long, in female 4.3–5.6.

Euchromadora amokurae (DITLEVSEN 1921a)

Cf. WIESER 1954

1 juv. Typical specimen. This is a species widely distributed in the Pacific area.

Neochromadora craspedota (STEINER 1916)

(Fig. 9 a–e)

1 ♂, 1 ♀

♂: L = 0.72 a = 28.0 b = 6.5 c = 7.7
♀: 0.80 21.4 7.2 7.2 Vu = 44,7%

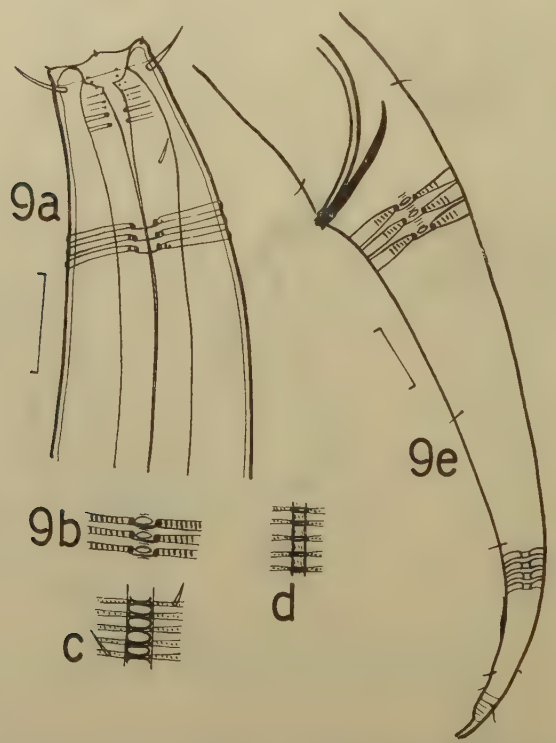


Fig. 9. *Neochromadora craspedota* (STEINER).
a, Anterior end of male; b, lateral cuticular structure in pharyngeal region; c, in mid-body; d, posterior to mid-body; e, posterior region of male.

I am convinced that I have refound STEINER's species although the spicular apparatus seems to be bigger than figured in the original description. The lateral membrane consisting of quadrangular plates, seems to be a good characteristic and is of exactly the same shape in my specimens as described by STEINER. There are

clearly two small hollow teeth present, the dorsal one being bigger than the subventral one. Their presence was only suspected by STEINER. Cephalic diameter 10.5μ. Diameter at end of pharynx 24μ. Cephalic setae 5.5μ long. There are 6 setose cephalic papillae. The cuticle consists of the usual bands with rod- or dot-like structures. Laterally they are interrupted by two longitudinal rows which are approximately 5μ apart. In the head region several rows of dots can be observed; then follows a region in which the transverse bands seem to be devoid of any secondary structures save the two lateral dots. At the end of the first third of the pharynx more and more rods make their appearance on the bands (figs. 9 a, b). At the level of the bulb the first traces of the lateral membrane can be seen between the two lateral rows. In the mid-body and further behind, the rods on the bands have changed into dots. The membrane is conspicuous and consists of quadrangular plates. This feature is best to be seen posterior to the middle of the body (fig. 9 d). In the anal region the membrane gradually disappears. There the bands are covered again with rod-like markings. All along the middle part of the body the lateral fields are accompanied by two sublateral rows of setae (fig. 9 c).

The spicula are 29μ = 1 anal diameter in length. The gubernacle measures approximately two-thirds of the length of the latter. It is cephalate distally, paired, and equipped there with two slightly outward-pointing teeth on each side.

The tail is 4 anal diameters long in the male, 6.5 in the female. Spinneret 9μ long.

Distribution: Öresound and North Sea, Arctic (Barents Sea), Campbell Islands. (Note: With the exception of the type specimens, all further findings were reported by ALLGEN who never described or figured the species again. Considering the doubtful status of the species this is regrettable since we cannot be sure whether ALLGEN really was dealing with STEINER's form).

Spilophorella tollenifera n. sp.

(Fig. 10 a–c)

7 ♂, 7 ♀

♂ 1:	L = 0.66	a = 21.6	b = 5.4	c = 6.6	
♂ 2:	0.75	21.7	6.1	7.8	
♀ 1:	0.73	19.0	5.7	7.6	Vu = 50.0%
♀ 2:	0.73	16.0	5.6	7.6	50.0%

Head diameter 14–15μ. Diameter at end of pharynx 27μ. Cephalic setae 8.5μ long in male, 7μ in female. Buccal cavity deep and large, with especially well developed diadema. Dorsal tooth powerful, with two sublateral, backward-pointing apophyses which end posteriorly in two knobs or pivots under the cuticle. The apophyses are 15μ long. A casual observer would only see the two posterior knobs, since they are refractive just as the "ocelli" in *Symplocostoma* or *Polygastrophora*,

and thus would consider them as "ocelli" too. A close examination, however, reveals their real nature which is purely mechanical.

The anterior end of the species seems to be slightly asymmetrical. In none of my specimens did I find the two longitudinal rows of cuticular dots in the lateral position which they assume in all other species of chromadorids. This might be due to the excessive development of the buccal armature. Opposite the dorsal tooth only a cuticularized pit in the buccal wall can be seen.

There are no cervical setae as in other species of this genus. The cuticle is typical for the genus. The longitudinal rows of dots have a distance from each other of 5μ in the anterior region (= one-fourth to one-sixth of the corresponding body diameter), 4μ in the mid-body (one-eighth), and 3.5μ in the anal region (one-sixth). The transverse bands are smooth in the anterior cervical region, becoming covered with more and more rod-like markings posteriorly. These rods change to dots in the mid-body, so that each band carries two rows of tiny dots (fig. 10 c). In the mid-body region traces of a lateral membrane can be seen. The pharyngeal bulb is double but not very well developed. It measures 34–39 × 22–26μ. The spicula are 29–31μ long, regularly curved, with slight projections at the proximal end. The gubernacle is simple and about half as long as the spicula. It carries no teeth or projections as is usual in other species of this genus.

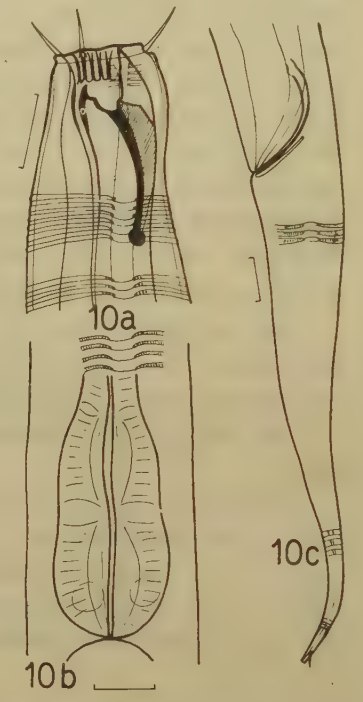


Fig. 10. *Spilophorella tollenifera* n. sp. a, Anterior end of male; b, pharyngeal bulb; c, posterior end of male.

The tail is 5 anal diameters long in both sexes. Spinneret 9μ long, provided with one or two setae.

This species is distinguished from all other species of *Spilophorella* by so many characters that it would be advisable in the future to reckon it to a distinct subgenus. These distinguishing characters are: The posterior apophyses of the dorsal tooth, the absence of cervical setae, the traces of a membrane in the mid-body, the simple structure of the male genital apparatus.

Spilophorella paradoxa (DE MAN 1888)

For synonyms and details see WIESER 1954.

1 typical female. The species is cosmopolitan. It is common on all European coasts and was also met with on both sides of the Pacific.

Chromadoropsis parva (DE MAN 1893)

Syn. *Spilophora, Chromadora, Chromadorina parva* auctores
Spilophora antarctica COBB 1914

3 ♂, 3 ♀

♀: L = 0.67 a = 24.7 b = 7.2 c = 5.6 Vu = 45.0%

The specimens are typical. The spiral amphids are relatively easy to observe. The tail of a female measures 8 anal diameters. The spinneret is 9μ long.

The species is known from the North Sea, Mediterranean, Red Sea, Campbell Islands, Antarctic, and Chilean coast.

Family Monhysteridae

Paramonhystera (*Leptogastrella*) *paranormandica* (MICOLETZKY 1922) aff.

1 ♀

Since I have only one female at my disposal an exact determination is difficult to obtain. In this subgenus the pilosity of the head is subject to some variation (cf. WIESER 1955). My single specimen shows apparently 12 cephalic setae, that is, less than MICOLETZKY (1924 b) describes. However, I found a similar variation in the closely related *P. pellucida* from the Chilean coast. The latter species and *P. paranormandica* are difficult to separate. The greater and more conspicuous amphids (60% of corresponding body diameter as against less than 50%) and the relatively longer tail of my specimen speak for *P. paranormandica*. However, without males it is impossible to decide whether one has not met with a new species.

♀: L = 1.20 a = 18.5 b = 5.0 c = 7.9 Vu = 68.4%

Head diameter 22μ. Cephalic setae 10.5μ long. Longest cervical setae 10.5μ long. Longest cervical setae at least 20–22μ long, that is about one body diameter. Amphids approximately 12μ wide. Tail 4.5 anal diameters long.

The species was hitherto known from the Mediterranean only.

Concluding Remarks

The nematode fauna of this sample is typical for seaweeds without much detritus. Most of the well known genera from such habitats are represented, such as *Enoplus*, *Oncholaimus*, *Viscosia*, and—above all—the Chromadoridae. This family, which is so characteristic for exposed algae, makes up two-thirds of the total population. On the other hand, the family most typical for habitats rich in detritus, i.e. the Monhysteridae, is only sparsely represented. *Chromadora nudicapitata*, so often the most common species in similar habitats of sea coasts all over the world is also the most abundant species in the Japanese sample.

One of the few genera which usually occur in such habitats but are lacking in this sample is *Anticoma*.

As to the geographical composition of the sample only very little can be said owing to the scarcity of our knowledge of the distribution of most species of marine nematodes. Anyhow, based on this limited knowledge the following groups of species can be distinguished:

1) *Pacific species.* Here belong the new species with exception of *Chromadorina inversa* which I know already from the Mediterranean, then *Viscosia carnleyensis*, *Polygastrophora tenuicollis*, *Paracanthonchus hawaiiensis* and *Euchromadora amokurae*. Of the latter four all but *Polygastrophora tenuicollis* are known from both sides of the Pacific.

2) *Species from the Indo-West-Pacific and the Mediterranean.*

To this group belong only three species: *Chromadora brevipapillata*, *Chromadorina inversa* and *Paramonhystera paranormandica*. It should be added that the determination of the last species is not quite reliable since only one female was present. These species occur neither on the east side of the Pacific nor in the Atlantic and Arctic.

3) *Species from North Atlantic-Arctic and the Pacific.*

Only *Desmodora scaldensis* and *Neochromadora craspedota*. The former species occurs also on the east side of the Pacific, the latter—according to ALLGEN—at the Campbell Islands (a cold-temperate area).

4) *Species with a more or less cosmopolitan distribution.*

This group comprises species which are known from the Atlantic, Mediterranean and both sides of the Pacific. They are: *Syringolaimus striaticaudatus*, *Oncholaimus dujardini*, *Eurystomina ornatum* (findings from the Pacific coast of America not quite reliable), *Halichoanolaimus robustus*, *Chromadora nudicapitata*, *Chromadorella filiformis*, *Spilophorella paradoxa* and *Chromadoropsis parva*. *Chromadora macrolaimoides* forms a transition between this latter group and group 2 since it is known from the Indo-West-Pacific, the Mediterranean and the Atlantic side of Central America, i.e. the Caribbean Sea and the Gulf of Mexico. Thus the species could be called "circum-tropical and -warm-temperate."

Summing up, the following grouping of the species can be recognized: 8 species, that is more than one-third, are cosmopolitan, amongst them the most abundant, *Chromadora nudicapitata*, and the third abundant, *Eurystomina ornatum*. To this group might be added *Chromadora macrolaimoides*.

7 species are Pacific, amongst them the second and fourth in abundance, *Euchromadora Tokiokai* and *Spilophorella tollenifera*, both new species.

The remaining 5 species have a distribution which in European-Asiatic waters is either subtropic-Mediterranean (group 2) or boreal-Arctic (group 3). None of these species is very abundant.

Finally the compatibility of the geographical distribution of the present species with EKMAN's rule may be discussed. It should, however, be kept in mind that here more than ever all conclusions must be regarded as preliminary since they are built on incomplete data.

EKMAN (see *e.g.* 1953, p. 72) states that the pelagic and abyssal region between outermost Polynesia and America is a very efficient barrier for the east-west dispersal of marine littoral animals. "The further we go from the rich Indo-Malayan Archipelago the poorer the littoral fauna becomes....." ..... "When, proceeding further east, we reach the coast of America we meet there with a fauna which, although living in the same ocean, nevertheless shows a decidedly closer relationship to the Atlantic fauna."

In a strict sense only the Indo-West-Pacific and the American warm-water Pacific fauna should be compared. The present nematode collection contains 7 species, of which 3 are new, belonging to these two faunal elements. If we regard the new species as restricted to the West-Pacific there are three species (*Viscosia carnleyensis*, *Paracanthonchus hawaiiensis* and *Euchromadora amokurae*) which occur on both sides of the Pacific.

However, if we take into account the whole material there are many more species which occur on both the west and the east coast of the Pacific. Since this result is brought about by including the more or less cosmopolitan species we can, at the present state of our knowledge, not be sure whether the dispersal of these animals has taken place across the Pacific or across the Atlantic by means of flotsam, or along the coasts of Japan, the Kurile Islands and the Aleutian Islands to the west coast of North America. This latter route is very probable since all the widely spread nematodes must be regarded as eurythermal and should be able to stand the low temperatures which they encounter in the cold-temperate and arctic climate of the North Pacific. With the exception of the three Pacific species mentioned above the following species occur on both sides of the Pacific: *Syringolaimus striaticaudatus*, *Oncholaimus dujardini*, *Halichoanolaimus robustus*, *Desmodora scaldensis*, *Chromadora nudicapitata*, *Chromadorella filiformis*, *Spilophorella paradoxa* and *Chromadoropsis parva*. Doubtful is *Eurystomina ornatum* which has been reported from California by ALLGEN (1947, 1951), but the data do not seem to be very reliable.

Chromadora macrolaimoides has hitherto not been found on the east coast of the Pacific, but on the Atlantic side of Central America. Thus we see that from the collection of Japanese nematodes at my disposal 8 cosmopolitan and 3 Pacific species are known to occur on both sides of the Pacific, to which perhaps can be added a doubtful species and one which probably will also be found on the American Pacific coast. These are altogether 13 species, that is to say, about 62% of the total of 21 nematodes determined.

This certainly supports the idea of the general cosmopolitan occurrence of marine nematodes which I myself have criticized in a recent paper (1953). However, I might take this opportunity to stress the extreme difficulty of classifying marine nematodes.

Although it seems to be fairly easy to determine nematodes from a well known area, the minute difference which might exist between closely related species from distant geographical regions are almost unkown. One certainly could not be proved wrong if one refused to accept any determination of marine nematodes from lesser know regions (that is to say, from all but the littoral of the North Atlantic and the Mediterranean) if they are not based on both males and females and accompanied by figures, or at least by absolute measurements and a succinct description. For example, in this paper I determined *Paracanthonchus hawaiiensis*, *Halichoanolaimus robustus*, *Desmodora scaldensis*, *Chromadora brevipapillata*, *Euchromadora amokurae*, *Spilophorella paradoxa* and *Paramonhystera paranormandica*, that is, one-third of all species, on the basis of females and (or) juveniles only, because I could not detect any differences between them and the typical species as known to me, or the original descriptions. It might be that there do not exist any noticeable differences in female, particularly not in juveniles, but that, nevertheless, the males would supply such small but distinct differences as would render necessary the establishment of separate species. I want to refer once again to the two species *Enoplus communis* and *E. michaelseni* which were admirably described by DE MAN in two papers (1886 and 1904). It is not possible to distinguish these two species on the basis of juveniles, whereas the males supply sufficient differential characters. If my doubts are true, this would very much upset all zoogeographical conclusions based on our present knowledge of the taxonomy of marine nematodes, including those touched in the present paper. Let us, for example, consider ALLGEN's paper on the nematode fauna of Hawaii (1951 part I). There are 53 species of which 23 were determined on the basis of females and juveniles, 9 on the basis of juveniles alone, together 32 species, or about 60% of the total of species found. If only a fraction of these 60% were wrongly classified this would give an entirely erroneous picture of the Hawaiian nematode fauna which would be perpetuated through the literature until correct and incorrect data became indistinguishable.

I do not advocate the suppression of all determinations based on females and juveniles (I myself do not follow this prudent advice), but I am convinced that, in order to render these determinations reliable, much more precise and painstaking methods of detecting and describing differential characters in nematodes have to be employed than has been (and is still) the case. Only by this means might we be able to assemble a number of incoherent and unreliable data into a system on which zoogeographical conclusions can be based.

To make a positive suggestion I consider it worth while undertaking an exact comparison between similar habitats of distant geographical regions in order to find out how great, or how small, is the similarity of the two nematode faunas. I hope to have contributed to this goal in my paper on the Chilean nematodes in which each species found was figured and described.

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ON THE POISONOUS SUBSTANCE CONTAINED IN HOLOTHURIANS[1]

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With 2 Text-figures

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I. Introduction

In the summer of 1929, when engaged in the experiment concerning cytolysis on epidermal cells of holothurians, the author found that marine fishes such as *Enedrias nebulosus*, *Girella punctata* and some others died within a few minutes, if the water extract of the tissues of *Holothuria vagabunda* Selenka[2] was added to the aquarium. In this connection the following was the processes through which the poisonous extract was made:

(1) scraping the body surface of *H. vagabunda* with sharp knife,

(2) braying small pieces of the cylindrical body wall *i.e.* the flesh part in a mortar with washed sand,

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1) Contributions from the Seto Marine Biological Laboratory, No. 253.

2) This species was originally described by Brandt as *Stichopus* (*Gymnochirota*) *leucospilota* in 1835, and later by Selenka as *Holothuria vagabunda* nov. sp. in 1867. The distribution and the anatomy of this animal in Japanese coast waters were reported in details by Mitsukuri in 1912.

(3) boiling pieces of body wall with sea water for about 5 minutes,

(4) cytolysing small pieces of the body wall with 0.4 mol. solution of kalium chloride.

A further research concerning holothurian poison had been interrupted for several years, but it was started again in the summer of 1941. For five years from 1941 to 1945, a series of experiments had been undertaken to clarify the nature of holothurian poison, especially of *Holothuria vagabunda*. In two years 1941 and 1942, about 140 kilogr. of *Holothuria vagabunda* was collected from the southwestern sea-shore of Wakayama Prefecture. From this collected material a new poison "Holothurin" was isolated in a crystallized form—chemically pure, and its chemical and physiological studies were executed. The new poison was found decidedly poisonous on many phylla of animals, especially on vertebrate animals.

The mechanism of poisoning on vertebrate animals has been made clear by a series of experiments to the effect that it is the destruction of red blood corpuscules or haemolysis. The existence of allied poisons has also been proved on another eatable and non-eatable 27 species of holothurians in Japan and in Palao Islands. The preliminary reports on this subject have been actually published in the following publications:

1) 1942. On the poisonous extract from holothurians. (in Japanese). Teikoku Gakushiin Hôkoku, 1942, p. 73.
2) 1943. On the distribution of poison in the body of holothurians. (in Japanese). Zool. Magazine, vol. 55, p. 87.
3) 1943. On the poison contained in holothurians. (in Japanese). Folia Pharmacologica Japonica, vol. 38, fasc. II, p. 115 §.

This study has been carried out at Seto Marine Biological Laboratory of Kyoto University and at Ogiu Laboratory of Institute for Chemical Research of the same University. The author expresses his sincere thanks to Prof. D. MIYADI (the director of the former) and Prof. K. OGIU (the director of the latter) for their kind guidance and encouragement.

II. Isolation and Purification of the Poison

Holothuria vagabunda SELENKA, inhabiting rocky sea-shore under tidal line, can be easily collected at the spring tide. In cold season (from September to April) this species migrates to deeper water and hibernates under stones. After taking off the viscera and the body fluid, the remaining thick body wall part of the flesh part consisting of epidermis, subepidermal connecting tissue, longitudinal and circular musculature, was washed by sea water and cut down to pieces. Adding possibly least amount of water, these pieces were boiled gently for about 15 minutes and filtrated. The filtrated brown colored water extract was further evaporated and condensed to viscious fluid on water bath. By adding 94% ethanol to this viscious fluid up to

60~70% alcohol content and then filtering, large amount of salt was separated. After this alcoholic solution was further distilled and condensed, large amount of absolute ethanol was added to the condensed extract up to 94% alcoholic content. White precipitate mainly composed of poison accompanying small amount of salt was thus obtained. As this poison is soluble in hot 94% ethanol but precipitates in cold one, hot crystallization in 94% ethanol was repeated for several times (at least 3–4 times). Then the poison was separated as colorless minute crystals containing no impurity such as salt and other organic substance.

The colorless precipitate revealed under microscope minute uniform needle-shaped crystal as indicated in Figs. 1 and 2. As later indicated in details, this substance showed intense poisonous effect on various animals. For the detection of poisonous

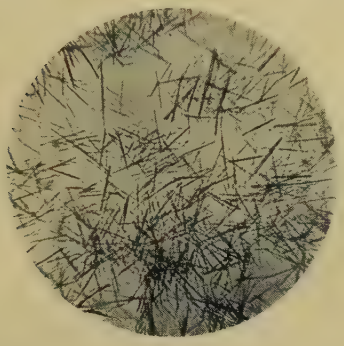

Fig. 1. Holothurin extracted from *Holothuria vagabunda*.
Suddenly crystallized from the concentrated solution in hot 94% ethanol. ×30.

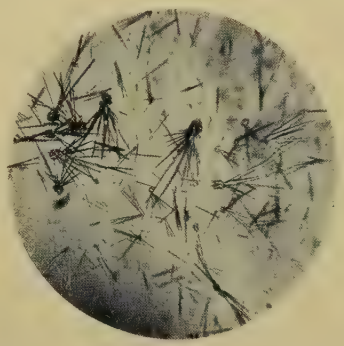

Fig. 2. Holothurin extracted from *Holothuria vagabunda*.
Slowly crystallized from the dilute solution in hot 94% ethanol. ×30.

effect, a small fundulus-like fresh water fish, red variety of *Oryzias latipes* (about 2 cm in length) was used. This fish can be purchased from a fish farm in large numbers, and can be easily kept healthy in laboratory. A single fish can survive for several days in 10 ccm water. This fish proved to be a very useful and convenient test animal for the detection of a poison soluble in water. The chemical nature of the poison is described in the following chapter.

The poison killed red var. of *Oryzias latipes* at 17°C in a solution of 1 : 200,000–1 : 250,000 (0.0004–0.0005%) in 24 hours.

Yield of the poison.

Year	Weight of fresh material	Weight of poison obtained	Content of poison for 1 kg material	Poison/material in %
1941	22 kg	11 gr	500 mg	0.05
1942	46 »	37.4 »	800 »	0.08

The part being used off in the preparation of poison, the viscera and the body fluid, were also found to contain poison, but in lesser degree than the body wall part. In 1942, from 46 kg raw material (cylindrical body wall) 37.4 gr poison was obtained. The body wall part is about half as heavy as of total body, therefore the whole body of the holothurian may contain about 0.05% poison instead of 0.08% as indicated in the lower row.

III. Chemical Nature of the Poison

A new poison has been found from *Holothuria vagabunda* SELENKA in the shape of colorless homogenous needle-like minute crystal (Figs. 1 and 2). It is hygroscopic and soluble in water at unlimited rate. It contains no crystal water. In fusion test (raising temperature at the rate of 2°C in 30″) at 194°C, it began to fuse partly, and at 206°C fused completely, but at the same time darkening accompanied gradually during fusion process. Therefore no definite fusion point measurement can be determined.

The water solution is colorless in dilute one, and in the condensed form it shows weak brownish color with yellow tint. The water solution is especially foaming or bubbling when stirred, and is resistant to heat and loses no poisonous effect on fish when boiled. It can not be dialized with ease through collodion membrane. It loses partly poisonous action by adsorption by animal charcoal. Large amount of animal charcoal is needed to abolish poisonous action completely. The minute crystals evoke strong sneeze when inhalated by nose. To a dog of medium size, piece of bread containing 50 or 100 mg of poison was given. After eating bread, the dog ejected the eaten bread with large amount of foaming mucus. The dog refused farther to take food containing the poison. No detectable taste was found when applied to the tip of tongue.

At room temperature it solves in ethanol containing water, but not in 94% ethanol. It is neither soluble in absolute ethanol, nor in other organic solvents of any sort.

It consists of carbon, hydrogen and of oxygen, but not of nitrogen. By qualitative test, it was found to have contained sulfur, phophorus and halogen. The water solution is unable to reduce Fehling's solution, but by acid hydrolysis it becomes to show positive reaction to TROMMER and α-naphthol test. 10 mg of the crystallized poison was hydrolysed with 5 ccm 5% HCl solution for one hour. The acidified solution was transparent, but gat turbid by being precipitated as the flask was being warmed on boiling water bath. The filtrate of the acid hydrolysed product reduced Fehling's solution, producing large amount of reduced substance. After neutralisation by sodium carbonate, the filtrate lost poisonous action on fish completely. The precipitate or the aglycon was soluble in chloroform, ether, absolute ethanol, aceton and in benzol, but not in petroleum ether.

10 mg poison was hydrolysed with 5 ccm 5% NaOH solution on boiling water bath for one hour. After hydrolysis it became viscious glycerin-like substance with lightly brownish yellow color, which showed no reaction to TROMMER and α-naphthol test. However, the glycerin-like end product, after neutralisation by acid, retained poisonous action on fish, though more weakened than before hydrolysis was treated by alkali. The original poison killed red var. of *Oryzias latipes* within 30 minutes in 0.01% solution, whereas the hydrolysed one treated by alkali required more than 90 minutes to produce the same effect on the same condition.

Moreover the cause of the poisonous action of the substance in question is, as in the next chapter described in details, the destruction of red blood corpuscules or haemolysis.

As described above, the chemical and physiological natures of the poison can be summarized as follows:

(1) water soluble,
(2) strongly foaming by stirring,
(3) evoking strong sneeze to human nose when inhalated,
(4) resistant to heat (not decoposed at 100°C),
(5) producing Fehling's solution reducing product by acid hydrolysis,
(6) having strong haemolytic action.

From these characteristics, it is reasonably concluded that the new poison extracted from *Holothuria vagabunda* SELENKA is very similar to plant glucoside saponin. The new poison may be estimated as a saponin-like compound of animal origin, and it may be named as "Holothurin".

IV. Action of the Poison "Holothurin" on Various Animals

a) On coelenterates, crustaceans and molluscs

COELENTERATA. Small pieces of the body wall of *Holothuria vagabunda* were boiled for 5 minutes with sea water of ten times in volume (for 10 gr weight of tissue added 100 ccm sea water). The brown-violet colored extract thus obtained was further diluted with sea water. The former extract is denoted for convenience 1:10 extract, the diluted one as 1:1000 extract, if the former was further diluted to 100 times.

Actinia equina. In 1:300 solution, gradual contraction. After 5 minutes total contraction (at 26.5°C).
In 1:1000 solution, after 30 minutes contraction began.

Cavernularia obesa. In 1:450 solution contracted instataneously.
In 1:4500 solution, contracted feebly.

CRUSTACEA. Marine crustacea *Pachygrapsus crassipes, Metapenaeus* sp. and *Eupa-*

gurus samuelis exhibited no remarkable change when they were immersed in 1 : 300 extract.

MOLLUSCA. *Aplysia kurodai* reacted same as crustaceans.

b) On land earthworm (lethal dose)

Six specimens of *Eisenia foetida* were put in the diluted solution of crystallized holothurin of various concentration. After 5 minutes immersion, they were taken out and washed with water and then placed in small petridish containing washed wet sand. After 24 hours they were examined to find whether alive or dead. Such experiments were accomplished with 150 animals.

Table 1. Immersion experiment of land earthworm *Eisenia foetida* in holothurin solution. Temp. 28°–29°C. For explanation see text.

Holothurin in %	Dilution	Number of animals	After 24 hours		Death rate in %
			alive	dead	
0.004	1 : 25,000	6	6	0	0
0.005	1 : 20,000	12	12	0	0
0.01	1 : 10,000	24	21	3	13
0.011	1 : 9,000	12	1	11	92
0.012	1 : 8,000	12	0	12	100
0.014	1 : 7,000	12	0	12	100

Thus the earthworms were killed within 24 hours by 5 minutes immersion in the solution of 0.012% (1 : 8,000). Being put in the poisonous solution, the earthworms exhibited instantaneously vigorously movement, and then they fall in paralysis, losing reaction to external mechanical stimulus such as pinch by biceps.

c) On fishes (saponin and holothurin)

When small marine fishes were put together with *Holothuria vagabunda* in a small aquarium, they showed not any unusual behavior to each other, whenever the surface of the holothurian was injured mechanically by sharp knife, and as a result brown violet fluid diffused into water, the fishes lost equilibrium and swam about obliquely in the water. They came later to death accompanying total paralysis. The same was true when water extract of poison was added to the aquarium. Marine fishes such as *Enedrias nebulosus*, *Girella punctata*, *Pomacentrus coelestis*, *Plotosus anguillaris* and *Thallosoma cupido* exhibited such reaction to the poison. In fresh water fishes, *Carasius auratus*, gold fish, wild and red variety of *Oryzias latipes* were tested with poisonous extract and similar result as in the case of marine fishes was observed. The same was also true when either extract or the pure poison was injected into the muscle part of fish.

As the mechanism of the poisonous action of holothurin revealed as haemolysis, it would be interesting if its action is compared with that of well known haemolytic reagent saponin. 5 fishes (red var. of *Oryzias latipes*) were put in a small finger bowel with 50 ccm tap water containing various concentration of either holothurin or of saponin (Merck's preparation). Survival time from the beginning to the death of fishes was closely observed.

Table 2. Comparison of the poisonous action of holothurin and saponin. Temp. 23°C. For explanation see text.

Result	Time interval in hours	Concentration in dilution		Ratio of concentration to evoke the same effect Saponin/Holothurin
		Saponin	Holothurin	
All 5 fishes died	1	1: 7,500	1: 75,000	10:1
All 5 fishes died	2	1:10,000	1:100,000	10:1
All 5 fishes died	6	1:20,000	1:250,000	12.5:1
2 among 5 fishes died	24	1:30,000	1:300,000	10:1
All 5 fishes died	24	1:25,000	1:250,000	10:1
All 5 fishes alive	24	1:40,000	1:400,000	10:1

From Table 2, it is clear that holothurin acts as venom to fishes 10 times more stronger than the most powerful haemolytic reagent saponin hitherto known. In some fishes bloody gills were observed by holothurin poisoning, what indicates holothurin would have penetrate into the fish body through gills. Comparison of the survival time in various concentration shows also the same effect as the result shown in Table 2.

Table 3. Comparison of the survival time in various concentration of venom. 10 fishes (red var. of *Oryzias latipes*) were put in 100 ccm solution. Temp. 21.5°C.

Saponin solution	1:1,000	1:2,000	1:4,000	1:8,000	1:16,000
Range of survival time in minutes	17–28	18–40	25–47	57–63	185–255
Mean survival time in minutes	21.4	26	36.5	63	208
Holothurin solution	1:10,000	1:20,000	1:40,000	1:80,000	1:160,000
Range of survival time in minutes	17–34	29–49	34–53	46–68	135–200
Mean survival time in minutes	23.9	37.2	44.3	58.4	156

In the course of poison test, it was revealed that the fresh water fish was more resistant to holothurian poison than the marine one, as follows: at 24.5°C the marine fish *Enedrias nebulosus* of the body length 3–4 cm died in holothurin solution of

1 : 50,000 (0.002%) within one hour, whereas the fresh water fish red var. of *Oryzias latipes* was killed in holothurin solution of 1 : 400,000 (0.00025%) within the same hour. The relative higher resistance of the fresh water fish to poison seems to be due to the lesser permeability of gills to external injurious chemical substance than the marine fish. The fresh water fish living in the stagnant water would be more adaptable to the variable chemical environment than the marine one.

d) On amphibians (lethal dose)

Into the abdominal cavity of *Rana nigromaculata* was injected small dose of holothurin solved in physiological salt solution. After 24 hours they were examined whether alive or dead.

Table 4. Lethal dose of holothurin to *Rana nigromaculata*.
For explanation see text.

Holothurin injected mg pro 10 gr body weight	Ratio of holothurin to body weight	Number of animals	Died within 24 hours	Death rate in %
0.1	1 : 100,000	6	0	0
0.2	1 : 50,000	4	0	0
0.4	1 : 25,000	10	2	20
0.5	1 : 20,000	14	2	14
0.6	1 : 16,000	7	3	43
0.7	1 : 14,000	10	6	60
1.0	1 : 10,000	8	7	88
1.2	1 : 8,300	8	8	100
3.0	1 : 3,300	3	3	100

e) On white rabbit (haemolysis)

As already mentioned in the chapter III, holothurin seems to be a sort of saponin-like compound in its physical and chemical nature. With red blood corpuscules of white rabbit, a series of experiments on haemolysis were accomplished to prove above criterion. Blood was taken from the ear of white rabbit, and after defibrization serum was separated by centrifuge. Ppted. blood cells were washed three times with physiological salt solution, and 1% (sometimes 2%) blood cells suspension in physiological salt solution was prepared.

Series of small test tubes with 5 ccm red blood cells suspension containing poison of various concentrations, were placed in 38°C thermostat. After 30 minutes the grade of haemolysis was measured, and the threshold concentration for complete haemolysis was determined for both poisons holothurin and saponin.

From Table 5 it is clear that holothurin acts as haemolytica from 6 to 7 times stronger than saponin of Merck's preparation. In the previous experiment of fish, the former was about 10 times more powerful than the latter (Table 2 and 3).

Table 5. Threshold concentration of holothurin and of saponin for complete haemolysis. Temp. 38°C. For explanation see text.

No. of rabbit	Concentration of blood cells suspension	Threshold concentration for complete haemolysis in %		Ratio of threshold concentration Saponin/Holothurin	Mean of ratio
		Saponin	Holothurin		
No. 2♀	1%	0.0017	0.00024	7.2	6.31
		0.0017	0.00025	7.1	
		0.0018	0.00034	5.4	
		0.0022	0.00037	5.9	
		0.0018	0.00030	6.0	
No. 3♂	1%	0.0023	0.00034	6.7	6.62
		0.0023	0.00039	5.9	
		0.0022	0.00033	6.6	
		0.0023	0.00035	6.4	
		0.0023	0.00030	7.5	
No. 4♂	1%	0.0025	0.00030	8.3	7.15
		0.0021	0.00031	6.8	
		0.0022	0.00033	7.6	
		0.0022	0.00033	6.7	
		0.0023	0.00035	6.4	
No. 4♂	2%	0.0030	0.00035	8.6	7.58
		0.0030	0.00040	7.5	
		0.0031	0.00040	7.8	
		0.0032	0.00045	7.0	
		0.0032	0.00045	7.0	

As well known, haemolytic action of saponin is reduced by cholesterin, and it is also generally accepted that such reduction in action may be due to the combination of saponin to cholesterin in blood (RANSOM 1901). To prove saponin-like nature of holothurin, the following experiment was undertaken. A small amount of cholesterin dissolved in ether was added to the dilute solution of holothurin, and test tubes containing mixed solution of holothurin and cholesterin were immersed in boiling water for 30 minutes in order to drive off ether completely. After cooling, sufficient amount of red blood cells suspension was added to the test tubes to hold 1% blood cells concentration in 10 ccm volume, and then the content of the test tubes was made 10 ccm by adding further sufficient amount of physiological salt solution.

Table 6 indicates that the threshold concentration of holothurin for complete haemolysis is 0.00034% (+ + +), but when 0.0005% of cholesterin is present, this value increases to 0.001% (+ + +), and by the presence of 0.001% cholesterin it becomes 0.0018% (+ + +), that is the action of holothurin for haemolysis is remarkably reduced by cholesterin, and this antitoxic action of cholesterin is roughly proportionally to the amount of cholesterin present. Therefore it may be reasonably

Table 6. Comparison of haemolytic action of holothurin and holothurin mixed with cholesterin. Temp. 38°C. +++, +, − indicate complete, incomplete and no haemolysis respectively.

No. of rabbit	Interval of haemolysis in minutes	Threshold concentration of holothurin for complete haemolysis in %	% of holothurin solution for haemolysis mixed with 0.0005% cholesterin	% of holothurin solution for haemolysis mixed with 0.001% cholesterin
No. 2♀	30	0.0003 +++	0.001 +++ 0.0005 −	
No. 3♂	60	0.0004 +++	0.0009 +++ 0.0006 −	0.0018 +++ 0.0015 −
No. 2♀	60	0.0003 +++	0.001 +++ 0.00075 −	0.00175 +++ 0.0015 −
No. 3♂	60	0.00035 +++	0.00125 +++ 0.001 + 0.00075 −	0.00175 +++ 0.0015 + 0.00125 −
No. 3♂	60	0.00035 +++	0.001 +++ 0.00075 −	0.00175 +++ 0.0015 −
Mean		0.00034 +++	0.001 +++ 0.00067 −	0.0018 +++ 0.0014 −

concluded that pharmacological action of holothurin may be similar to that of saponin, or that holothurin may be estimated as animal saponin as compared with plant one.

f) On mouse (lethal dose)

To determine the lethal dose of holothurin, crystallized holothurin was applied to mouse either by peros application, or subcutaneous and intravenous injection. 249 mice were used for such experiments, and the result is summarized in Tables 7, 8, 9 and 10.

Table 7. Lethal dose of holothurin by intravenous injection of holothurin to the tail vein of mouse.

mg of holothurin injected pro 10 gr body weight	Ratio of Holothurin /body weight	Number of mice	Number of mice died within the hours indicated					
			1h	2h	6h	24h	48h	72h
0.0015	1 : 6,660,000	6	0	0	0	1	1	0
0.0025	1 : 4,000,000	18	0	0	1	0	0	2
0.00375	1 : 3,000,000	12	0	0	5	1	2	1
0.005	1 : 2,000,000	18	0	0	5	3	0	1
0.00625	1 : 1,600,000	12	0	0	5	3	4	
0.0075	1 : 1,330,000	12	0	3	7	2		
0.01	1 : 1,000,000	12	0	0	6	6		
0.015	1 : 666,000	6	3	1	1	1		
0.025	1 : 400,000	6	5	1				

Table 8. Subcutaneous injection of holothurin to mouse.

mg of holothurin injected pro 10 gr body weight	Ratio of Holothurin /body weight	Number of mice	Number of mice died within the hours indicated					
			1h	2h	6h	24h	48h	72h
0.1	1 : 100,000	9	0	0	0	0	0	0
0.2	1 : 50,000	21	0	0	0	1	4	2
0.3	1 : 33,300	13	0	0	0	6	2	0
0.4	1 : 25,000	12	0	0	0	6	2	1
0.5	1 : 20,000	6	0	0	0	4	0	0
0.6	1 : 16,600	6	0	0	0	4	0	0
0.7	1 : 14,300	6	0	0	0	6		
1.0	1 : 10,000	12	0	0	3	9		
2.0	1 : 5,000	7	0	0	5	2		

Table 9. Peros application of holothurin to mouse.

mg of holothurin peros given pro 10 gr body weight	Ratio of Holothurin /body weight	Number of mice	Number of mice died within the hours indicated					
			1h	2h	6h	24h	48h	72h
0.5	1 : 20,000	6	0	0	0	0	0	0
0.75	1 : 13,000	6	0	0	1	0	1	0
1.0	1 : 10,000	6	0	0	0	0	0	0
1.25	1 : 8,000	6	0	0	0	0	0	0
1.5	1 : 6,600	6	0	0	1	0	0	0
2.0	1 : 5,000	6	0	0	1	2	0	0
2.5	1 : 4,000	6	1	0	1	1	0	0
3.0	1 : 3,300	6	0	1	1	2	0	0
4.0	1 : 2,500	6	2	2	0	2		

Table 10. Comparison of the lethal dose of holothurin to mouse, died within 24 hours by different modes of application.

Mode of application	mg of holothurin pro 10 gr body weight of mouse	Ratio of lethal dose to body weight	Relative ratio of lethal dose
Intravenous injection	0.0075	1 : 1,330,000	1
Subcutaneous injection	0.7	1 : 14,300	93
Peros application	4.0	1 : 2,500	532

The symptoms of the intoxicated mice. After the application of holothurin, the mice lost compensation in locomotory movement, and then there came paralysis in which the fore legs were attacked at first, and later followed by the hind ones. Reaction to mechanical stimulus, such as insert by biceps, was totally lost. When the paralysed mice placed on their back position, they were no more able to do righting reaction. In some animals nose bleeding due to lung blooding was observed.

The anatomical appearance of the intoxicated mice. By dissecting carcass, the intoxicated mice showed generally hyperaemia on thoracic and abdominal cavity surface, on intestinal outer surface, on liver and milz, and blooding in lungs. By subcutaneous injection of holothurin, the injected region showed injuratio accompanying oedem, and surrounding part became congested. In animals peros holothurin given, gas was filled in stomach and intestine, and the interior of the latter was filled with mucus like viscious fluid.

V. Poisons of Holothurians in Japan and in South Sea Islands

In South Sea Islands, holothurians are not unusual food for the natives, for instance in Palao Islands among 12 spp. of holothurians commonly found in coral reefs, 10 spp. are adopted as food by the natives. In Japan two spp. (*Stichopus japonicus* and *Cucumaria japonica*) are sold at market in winter season. Moreover holothurians are prepared as trépang (haishên) and are exported to China from Japan and South Sea

Table 11. Relative grade of venom contained in the holothurians inhabiting the Japanese coast waters.

Animal	Grade of venom for fish	Grade of haemolysis for rabbit red blood cells	Locality
Holothuria vagabunda	+ + +	+ + +	Seto
H. monacaria	+ + +	+ + +	„
H. lubrica	+ +	+ + +	„
H. pervicax	−	−	„
Stichopus japonicus	+	+	„
St. oshimae	−	−	„
Cucumaria japonica	+	+	Onagawa
C. sp.	+ +	+ +	„
C. echinata	+	+	„
Pentacta australis	+	+	„
Pseudocucumis africana	+ + +	+ +	Seto
Caudina chilensis	+	−?	Asamushi
Molpadia sp.	−	−	Onagawa
Polycheira rufescens	+ + +	+ + +	Seto
Leptosynapta ooplax	+ + +	+ + +	„

Islands. In the preparation of trépang, gutted holothurians are firstly boiled in water, and then dried in the air by sun light. It is certainly a necessary and interesting problem to investigate whether other holothurians contain similar poisonous substance as holothurin or not.

Fresh material was collected at several marine biological stations in Japan, Seto (Kyoto University), Onagawa (Tohoku Univ.) and Asamushi (Tohoku Univ.). When it was unable to accomplish precise experiment at seashore, gutted holothurians were weighed and conserved in alcohol. Such material was later warmed on water bath to expel alcohol, and then water extract was prepared. For the test of holothurians in South Sea Islands, trépang which was brought by the author from Palao Islands in 1941, was utilized.

For the detection of poison contained in holothurians, two methods were adopted. 1) Small pieces of the body wall of holothurians were cut off, and after weighing they were boiled with water for about 5 minutes, water extract thus obtained was if necessary further diluted with water. In such extracted solution, reaction of marine or of fresh water fishes was observed. 2) Haemolytic action of extract on rabbit red blood cells was observed.

For the detection of poisonous substance of trépang preparation, thin flakes of each sort were boiled with water of 100 times in weight, and thus 1 : 100 water extract of trépang was prepared. The survival time of red var. of *Oryzias latipes* in these solutions was measured (10 fishes in 100 ccm water extract).

Table 12. Venom of trépang preparation in Japan and in South Sea Islands. Survival time of red var. of *Oryzias latipes* in 1 : 100 extract was measured. Temp. 21.5°–22.5°C.

Animal	Number of fishes	Mean survival time of fish in minutes	Grade of venom
Holothuria atra	24	26	+ + +
H. scabra	24	48	+ +
H. bivittata	24	42	+ +
H. argus	24	37	+ +
H. sp.	41	34	+ +
H. lecanora var.	25	37	+ +
H. nobilis	41*	116+X	+
H. axiologa	24	25	+ + +
Stichopus variegatus	24	29	+ + +
St. chloronotus	30	34	+ +
St. japonicus	41	59	+ +
Parastichopus nigripunctatus	34	173	+
Cucumaria japonica	14	34	+ +
Thelenota ananas	49	28	+ + +

* 13 fishes among 41 survived longer than 360 minutes, and were excluded from the mean.

Table 13. Grade of venom of trépang preparation measured by the time for complete haemolysis. inst. denotes instataneous haemolysis; trace, + denote trace and partial haemolysis respectively in 3 hours. − denotes no haemolysis.

Animal	Time for complete haemolysis in minute and second — Amount of extract (1:100) added to 5 ccm 1% blood cells suspension				Grade of venom
	2 ccm	1.0 ccm	0.5 ccm	0.25 ccm	
Holothuria atra	inst	10″	20″	60″	+ + +
H. scabra	inst	3′ 30″	15′	+	+
H. bivittata	inst	3′	15′	+	+
H. argus	inst	30″	1′ 40″	8′	+ +
H. sp.	inst	1′ 20″	3′	20′	+ +
H. lecanora var.	inst	50″	2′ 30″	8′	+ +
H. nobilis	trace	−	−	−	− ?
H. axiologa	inst	20″	70″	3′	+ + +
Stichopus variegatus	inst	12″	40″	3′	+ + +
St. chloronotus	inst	30″	70″	2′ 40″	+ + +
St. japonicus	inst	15′	+	trace	+
Parastichopus nigripunctatus	+	+	trace	−	+
Cucumaria japonica	inst	5′	30′	+	+
Thelenota ananas	inst	10″	20″	1′ 20″	+ + +

Table 14. Combining the results shown in the tables 12 and 13, the relative grade of venom contained in trépang preparation is presented.

Animal	Grade of venom for fish	Grade of haemolysis for rabbit red blood cells	Locality	Commercial name of trépang
Holothuria atra	+ + +	+ + +	Palao Isl.	wutiao (烏條)
H. scabra	+ +	+	»	paishên (白參)
H. bivittata	+ +	+	»	chihshên (赤參)
H. argus	+ +	+ +	»	wen (紋)
H. sp.	+ +	+ +	»	tawuyüan (大烏元)
H. lecanora var.	+ +	+ +	»	hsiaowuyüan (小烏元)
H. nobilis	+	− ?	»	yenshên (岩參)
H. axiologa	+ + +	+ + +	»	hsiangpishên (象鼻參)
Stichopus variegatus	+ + +	+ + +	»	yüshên (玉參)
St. chloronotus	+ +	+ + +	»	hsiaofangshên (小方參)
St. japonicus	+ +	+	Japan	iriko
Parastichopus nigripunctatus	+	+	»	okiko
Cucumaria japonica	+ +	+	»	kinko
Thelenota ananas	+ + +	+ + +	Palao Isl.	meihuashên (梅花參)

Table 15. List of 27 spp. of holothurians in Japan and in South Sea Islands as to whether they contain poison or not. Summarized from the tables 11 and 14.

Animal	Poison for fish	Haemolysis for rabbit blood cells	Habitat	Local name of holothurians in Palao Islands
Holothuria vagabunda	+	+	Seto	
H. monacaria	+	+	"	
H. lubrica	+	+	"	
H. pervicax	−	−	"	
H. atra	+	+	Palao Isl.	chauas
H. scabra	+	+	"	molch
H. bivittata	+	+	"	molch
H. argus	+	+	"	bibak madal
H. lecanora var.	+	+	"	karamrm
H. sp.	+	+	"	ngallau
H. nobilis	+	−?	"	bad le chaled
H. axiologa	+	+	"	molch
Stichopus japonicus	+	+	Seto	
St. oshimae	−	−	"	
St. variegatus	+	+	Palao Isl.	blaom
St. chloronotus	+	+	"	ngkasugl
Parastichopus nigripunctatus	+	+	Japan Sea	
Cucumaria japonica	+	+	Onagawa	
C. sp.	+	+	"	
C. echinata	+	+	"	
Pentacta australis	+	+	"	
Pseudocucumis africana	+	+	Seto	
Caudina chilensis	+	−?	Asamushi	
Molpadia sp.	−	−	Onagawa	
Polycheira rufescens	+	+	Seto	
Leptosynapta ooplax	+	+	"	
Thelenota ananas	+	+	Palao Isl.	tamataml
Number of species containing poison	24	22	% of species containing poison 24/27×100=89%	
Number of species containing no poison	3	5		

To compare haemolytic action, different amounts from 0.25 to 2 ccm of the water extract (1 : 100) of each trépang preparation was added to 5 ccm 1% red blood cells suspension of rabbit. The water extract was made to contain 0.9% sodium chloride by adding sufficient amount of salt. The time to complete haemolysis was measured by stop watch.

Among 27 species of which 16 are from Japanese water, and 11 from South Sea Islands, 24 species contain substance venomous to fish and 22 species to rabbit red blood cells, or more than 80% holothurian species were found containing poisons of various strength. It may be maintained that holothurians generally contain poison with a few exceptions. Each species seems to contain chemically different poison notwithstanding its physiological action is alike. In Table 16, solubility of holothurian poisons in ethanol is compared.

Table 16. Solubility of holothurian poisons in ethanol at room temperature. sol and ppt denote soluble and insoluble respectively.

Animal	Percentage of ethanol					
	0	50	55	90	94	100
Holothuria vagabunda	sol	sol	sol	sol	ppt	ppt
Stichopus japonicus	sol	sol	sol	sol	sol	sol
Cucumaria japonica	sol	sol	sol	sol	ppt	ppt
Polycheira rufescens	sol	sol	ppt	ppt	ppt	ppt
Caudina chilensis	sol	sol	sol	sol	sol	sol

Poisons of *Holothuria vagabunda* and *Cucumaria japonica* show same solubility to alcohol, but the minimal concentration for complete haemolysis of 1% red blood cells suspension in 30 minutes was in *H. vagabunda* 0.0002–0.0004%, and in *C. japonica* 0.001%. *Caudina chilensis* and *Stichopus japonicus* contain poison soluble to absolute alcohol, but the venom of the former was decidedly stronger than the latter. From these facts it is clear that the various poisons contained in holothurians are specific to each species. The grade of venom and also the presence or absence of the poison in various species of holothurians are independent of the genus to which each holothurian belongs as indicated in Tables 11, 14 and 15.

Distribution of poison in the body of holothurians. The body wall or the flesh part of holothurians has been proved to be poisonous to various animals. In order to know whether the other part of the body contains poison or not, the following procedure was adopted. Several organs of holothurians were separated and weighed, and then boiled with water of 10 parts for 10 minutes. The water extract was diluted with the same volume of water; thus 1 : 20 extract was prepared. In each extracted solution of 100 ccm, 7 fishes (red var. of *Oryzias latipes*) were put and the survival time from immersion to death was observed. The venom of the different organs was also measured by haemolytic method, in which one ccm of 1 : 10 extract

of each organ containing 0.9% salt was added to 5 ccm of 1% rabbit red blood cells suspension, and the time for complete haemolysis was measured.

Table 17. Venom in different organs of *Holothuria vagabunda*.

Part of body	Mean survival time of seven *O. latipes* in 1 : 20 extract	Time for complete haemolysis in minute & second	Water content in %
Body wall	15.8 minute	13″	89
Cuvier's organ	16.4 »	10″	91
Intestinal haemal vessels	17.4 »	1′30″	83
Digestive canal	28.1 »	15′	90
Longitudinal muscle	43.6 »	10′	80
Ovarium	48.0 »	2′	–
Temp. in C	24	26.5	

As the water content of each part or organ varies from 80 to 90%, the difference in survival times of fish in each extract indicates clearly the varied content of holothurin in each organ.

The body fluid of *H. vagabunda* also contains poison. Body fluid from a single individium was divided into two equal parts (a and b):

a–part was boiled for a few seconds in order to destruct blood cells; in b–part blood cells were precipitated by centrifuge, and the precipitate was boiled with the same volume of sea water; c–part was prepared by boiling the filtrate of b–part.

a, b and c were diluted with 4 parts of sea water. The venom of these three parts (a, b and c) was measured with the marine fish *Enedrias nebulosus*.

Table 18. The venom of the body fluid of *Holothuria vagabunda*. Marine fish *Enedrias nebulosus* was put in diluted fluid and the survival time was observed. For one fish 50 ccm solution.

No. of experiment	Temp. in C	Number of fish	Mean survival time in minute		
			a (whole body fluid)	b (blood cells only)	c (serum only)
1	27	12	19.3	21.5	78
2	27	18	23.7	21.7	150
3	28.5	15	15.6	18.0	38.2
4	28.5	18	17.3	16.3	49.5
5	27	21	21.4	24.7	50.7
Mean			19.5	20.4	73.3

The survival times of fishes are almost equal in the whole body fluid and in the blood cells only. In *Holothuria vagabunda* the major part of poison holothurin

is located in blood cells, but the minor part is also present in serum. The body fluid is able to haemolyse red blood cells of rabbit. When 1 ccm body fluid was after boiling added to 5 ccm 1% blood cells suspension of rabbit, the blood cells underwent complete haemolysis in 2′ 20″ at 26.5°C. The distribution of poison in this holothurian extends to every organ including body fluid, though somewhat different in content between organs (Table 17). The function of the poison holothurin in the metabolism of holothurians is not clear at present, as it has not yet been investigated.

In some animals other than holothurians, test was made as to the existence of poisonous substance to fish at Seto Marine Biological Laboratory. Only the starfish *Asterina pectinifera* proved to contain substance poisonous to fish, though somewhat one-tenth so weak as compared with the poison of *Holothuria vagabunda*. On the same condition at 27°–28°C.

Asterina pectinifera—1 : 100 extract killed *Girella punctata* in 48 minutes.

Holothuria vagabunda—1 : 300 extract killed the above fish in 12 minutes.

V. Interpretation

In Japan two species of holothurians, *Stichopus japonicus* and *Cucumaria japonica* are eaten raw. Nevertheless, no case is hitherto reported concerning poisoning. The reason of this may be assumed as follows:

(1) These edible species contain weaker poison than the unedible species such as *Holothuria vagabunda* and *H. monacaria* (Table 11). Even the species containing strong poison would be harmless, so far as being not too much eaten.

(2) Holothurian poison is most dangerous when it enters into blood circulation (haemolysis), but it is not so harmful when eaten. From Table 10 the relative lethal dose of holothurin for mouse is as follows:

intravenous injection	1
subcutaneous injection	93
peros application	532

(3) As reported in the chapter III, holothurin loses completely poisonous action by acid hydrolysis. Some part of eaten poison may undergo decomposition by peptic acid during digestion and weaken in poisonous action.

From these standpoints holothurians do not seem to be harmful food. On the other hand, holothurian poison may exert more or less useful effect as food, in so much as saponin or allied substance would be needed, because holothurin or allied poison is from its chemical and physiological natures considered as saponin-like compound. In Japanese coast waters there dwell about 40 species of holothurians (excepting deep water fauna), 16 species among them have been examined as to poisonous substance (Table 11). The edible two species would become eatable because of their having thick body wall and of good taste, and the other species

would have become untouched as food because of their unsavouriness or of bitter taste or of their poisonous effect learned by long experience since prehistoric ancient time.

Stichopus japonicus is a popular diet in Japan in winter season. It contains poison, but its venom is so weak as such that 1 : 20 extract (pieces of the body wall were boiled with 20 times of water for 5 minutes) killed only 2 of 5 fishes (red var. of *Oryzias latipes*) in 24 hours at 22.5°C. In *Holothuria vagabunda*, the 1 : 20 extract killed all 7 of the above fish within 19 minutes at 24°C. Iriko (trépang preparation of *Stichopus japonicus*) shows somewhat stronger venom than the fresh material like that 1 : 100 extract killed all 41 of the same fish within the range of 40–130 minutes (in the average of 59 minutes) at 22.5°C. As to the venom of trépang details are discussed below.

4 sorts of trépang (*Holothuria atra, H. axiologa, Stichopus variegatus* and *Thelenota ananas*) of South Sea origin show relatively higher poisonous content than the other (Table 14). This is, however, in no way a serious problem, for in cooking of trépang the large amount of poison, even if it existed, should be taken away in such a way as follows: The trépang is boiled with water for about one hour and let stand overnight. On the next day the same process is repeated, and such procedure is continued usually at least for three days till it becomes soft enough to be edible. In Palao Islands among 4 trépang species mentioned above, *Holothuria atra* is not utilized as food, and of other 3 edible species the body wall part is eaten raw in *H. axiologa* and in *Thelenota ananas*. In *Stichopus variegatus*, only the intestine is eaten raw mixed with salt by the natives. They gather *St. variegatus* (blaom) at dawn at low tide, when the intestine of the holothurian vacant (YAMANOUCHI 1939, p. 622). Of course not all the holothurians are utilized as food by the natives in Palao Islands, and the mode of cooking is not always the same. In most cases the body wall or the flesh part is cut into pieces and eaten raw with salt or with sea water.

Besides *Stichopus variegatus* mentioned above, an unusual case is of *Holothuria scabra*, whose testis is made use of food at times by the natives of Korôru village in Palao Islands. A salted viscera of *Stichopus japonicus* is also relished with wine in Japan in winter season. Such common habit between Japanese and South Sea Islanders in utilizing holothurians as food, is very interesting problem in ethnography. In spite of the fact that most of the holothurian species contain saponin-like poison, they are by no means injurious as food, though whether they are eaten raw or utilized as trépang in so much as habitually hitherto adopted species being selected.

According to Assist. Prof. T. TOKIOKA of the Seto Marine Biological Laboratory, who visited the Tokara Islands (southwest of Kagoshima Prefecture) in 1943, the islanders eat *H. vagabunda* raw mixed with vinegar or boiled. They utilize also *H. vagabunda* as fish poison in such a way that mashed holothurians with stone are poured into tide pool, and after a while paralysed fishes with holothurian poison are gathered and utilized as food.

Nothing is known of the physiological meaning of the poison in holothurian metabolism. Is there any ecological significance of the holothurian poison?

It is clearly assured that fishes may undergo paralysis and finally become to death by holothurian poison as already described, if they bite holothurians containing strong poison. In nature, it would be possible that fishes attack holothurians containing strong poison and learn by trial and error to avoid such holothurian. But in the sea and also in aquarium fishes seem to be indifferent to holothurians, because the latter would lack perhaps keys to attract fishes. In the living world there are characteristics independent of natural selection viz. devoid of selection value, and in such case consequently such characteristics would develope on its own accord in the course of evolution. The epidermal coloration and its marking pattern of holothurians belong surely to such category (YAMANOUCHI 1942a). Of the question that whether holothurian poison would belong to such case or not, the author is of the opinion that holothurian poison has little ecological significance.

VI. Summary

1. From *Holothuria vagabunda* SELENKA, a new poison "Holothurin" has been isolated as chemical pure crystal. This substance is composed of C, H, O, but not of N. By acid hydrolysis it becomes to reduce Fehling's solution, and loses poisonous action to fish. The aglycon is soluble in organic solvents other than petroleum ether. By alkali hydrolysis it becomes glycerin-like viscious substance, and is weakened much in poisonous action than the original poison.

2. This substance in its chemical and physiological natures very much resembles plant glucoside saponin in such manner as:

(1) water soluble,
(2) strongly foaming by stirring,
(3) evoking strong sneeze to human nose when inhalated,
(4) heat resistant,
(5) producing Fehling's solution reducing product by acid hydrolysis,
(6) having strong haemolytic action to rabbit red blood cells.

3. The venom of holothurin is much stronger than that of saponin of Merck's preparation. For fresh water fish red variety of *Oryzias latipes*, the former is about 10 times more poisonous than the latter. The threshold concentration for complete haemolysis of rabbit red blood cells is in holothurin about 1/7 of that of saponin.

4. Lethal dose of holothurin for land earthworm, frog, fish and mouse have been measured. For mouse the lethal dose in 24 hours are pro 10 gr body weight of mouse,

intravenous injection	0.0075 mg.	(1 : 1,330,000)
subcutaneous injection	0.7 mg.	(1 : 14,300)
peros application	4.0 mg.	(1 : 2,500)

5. Haemolytic action of holothurin is much reduced by the presence of cholesterin, and this reduction is roughly proportional to the amount of cholesterin present.

6. Holothurin distributes in all parts or organs of *Holothuria vagabunda* including the body fluid. The amount of poisonous content is different according to each type of organs. In body fluid, major amount of poison is located in blood cells.

7. Of 27 holothurian species in Japan and in South Sea Islands, 24 species have been proved to contain substance poisonous to fish and 22 species to have haemolytic action, that is more than 80% holothurian species have been proved to contain more or less poison.

8. 13 sorts of trépang preparation have been examined whether they contain poison or not. All sorts examined have been proved to contain poison. Notwithstanding the presence of poisonous substance, no case is hitherto reported as to poisoning. The reason for this has been discussed.

9. The poison contained in holothurians are not common among species. They are specific to each species. No relation has been found as to the presence or absence or as to the grade of the content of poison between genera of holothurians.

10. Poisons contained in holothurians seem to have little ecological significance. There should be some meaning of the presence of poison in the metabolism of holothurians, considering the chemical nature of holothurin.

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CONTRIBUTIONS TO JAPANESE ASCIDIAN FAUNA

XI. SPORADIC MEMORANDA (2)[1)]

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With Plates XI–XIV and 5 Text-figures

CONTENTS

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1. Some Ascidians from the East China Sea.

(Pl. XI; Text-fig. 1)

I had a chance to examine a few specimens of tunicates which were trawled in the East China Sea during the oceanographical surveys carried out by members of the Seikai Regional Fisheries Research Laboratory. This small material contains the following 4 species.

Didemnum (*Didemnum*) *apersum* TOKIOKA
Syndiazona grandis OKA in "*Aphanibranchion*" state
Syndiazona chinensis n. sp.
Pyrosoma atlanticum atlanticum (PERON)

Before going further, I express my hearty thanks to Messrs. T. TSUJITA and H. YAMASHITA of the Seikai Regional Fisheries Research Laboratory, by whose courtesy I was able to get the chance to examine the material. Also I must record here that the present short note is one of the contributions from the Seikai Regional Fisheries Research Laboratory.

1. *Didemnum* (*Didemnum*) *apersum* TOKIOKA, 1953

(Pl. XI, Figs. F & G)

A small, 10 mm×8 mm in extent, white colony was found on a specimen of

1) Contributions from the Seto Marine Biological Laboratory, No. 254.

Edwardsia sp. It is ca. 1 mm in thickness. Surface echinate (Pl. XI, fig. F); finger-shaped protuberances rather small, less than 260 μ in length. Some depressions on the surface are coloured faintly grayish yellow. Spicules small, 22 μ in average diameter and up to 26 μ in larger ones; about 10 rays on the equatorial plane, rays rather short and bluntly pointed at the tip. They are distributed uniformly and densely throughout the colony. Average distance between zooids ca. 570μ. Zooid small; thorax ca. 400μ in a contracted state and has a fan-shaped thoracic tubercle at the dorso-posterior part on each side and a retractor muscle nearly as long as the contracted thorax, abdomen ca. 400μ in length. Gonad quite immature.

The present specimen conforms well to the type specimen in size and appearance of spicules, but differs in the following three points: ··· 1) finger-shaped protuberances on the colony surface are smaller, 2) spicules distributed uniformly and densely, and 3) zooids smaller in the present specimen.

Loc.: 27° 35–40′N × 125° 01–16′E, 100 m. July 9, 1954.
Sp. No.: Asc. 56.

2. *Syndiazona grandis* Oka, 1926

One specimen in "*Aphanibranchion*" state. Corona roughly spherical, 50 mm × 30 mm in transverse section and ca. 50 mm in height. Peduncle thick and ca. 40 mm in length. The colony is dark brownish in colour; the surface is generally smooth, although a few irregular grooves are found there. Zooids are not in good condition, thoraces being wholly lost. Stomach is situated evidently in the posterior half of the abdomen.

Loc.: 29° 08–12′N × 126° 10–22′E, 93 m. July 10, 1954.
Sp. No.: Asc. 54.

3. *Syndiazona chinensis* n. sp.

(Pl. XI, Figs. A–E; Text-fig. 1)

A 120 mm × 65 mm colony fastening the gravels and shell fragments at the underside. It is 15–25 mm in thickness, margin is very thin at some places. Test grayish brown in colour and translucent, zooids are seen through. Surface smooth and free from foreign matters.

Zooid: Yellowish brown in colour in preservation in formalin. Thorax up to 4.5 mm in length, abdomen 5–6 mm. A long vascular prolongation is issued from the posterior end of the abdomen; it is rather thick, yellowish brown in colour and may be long as much as 25–30 mm. Neck region extremely thin, of moderate length and coloured dark greenish.

Thorax: Both branchial and atrial apertures 6-lobed, with an orange ocellus at each interval between lobes; the atrial siphon is slightly longer than the branchial. About 10 longitudinal muscles on each side of the thorax besides ca. 8 short ones at the dorso-posterior side of the atrial siphon. Six to seven of the long muscles on the ventral side are running rather obliquely, with their posterior ends meeting the endostyle obliquely and being bifurcated in the posterior half of the thorax. The ventral half of thoracic muscles proceeds anteriorly towards the base of the branchial siphon, while the dorsal half reaches anteriorly to the base of the atrial siphon. Thus the area neighbouring the dorsal ganglion is quite free from muscles. Muscle fibres of thoracic muscles are, however, not continuous with those of siphonal muscles.

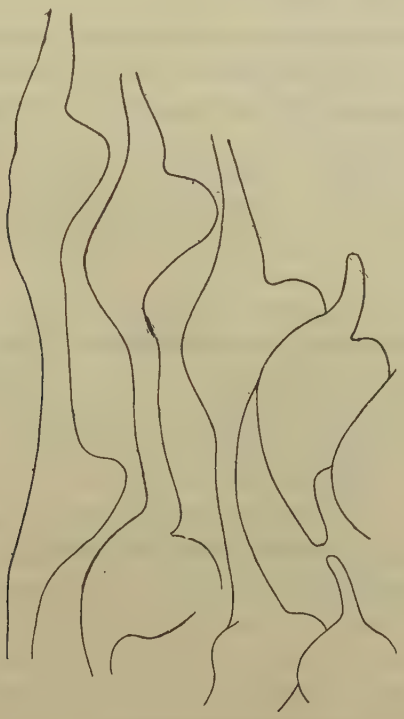

Fig. 1. *Syndiazona chinensis* n. sp. A part of the inner surface of the branchial sac, ×280.

Transverse muscles absent. There are about 10 transverse vessels on each side; they are rather thick and seem at a glance as if they were transverse muscles, although the microscopical examination easily reveals their haemal structure. Thirty to thirty-five stigmatal rows, dorsal languets slightly displaced to the left from the dorsal mid-line. Stigmata in a row numerous, transverse vessels are provided each with ca. 40 papillae which support each a thin inner longitudinal vessel (Fig. 1). Usually 1-2 stigmata in a mesh. Tentacles (Pl. XI, fig. D) very fine, comprise 6 large, 6 medium and 12 small ones which form another ring slightly in front of the ring consisting

of large and medium ones. Ciliated groove a short longitudinal slit (Pl. XI, fig. E). Anus bilobed and situated on the level of about the 10th transverse vessel.

Abdomen: Oesophagus short. Stomach situated in the anterior half of the abdomen and large, about 1/3 as long as the abdomen. The surface is smooth, but the longitudinal plications on the inner wall, ca. 30 in number, are seen through. Hind stomach and mid-intestinal region distinct; the latter rather long and constricted from the rectum near the posterior end of the abdomen. Gonad was not found in any zooid. All organs in the abdomen are completely embedded in the mesenchyme tissue. Posterior ends of several dorsal ones of thoracic longitudinal muscles are united into two muscular bands which run along a side of the abdomen and proceed into the posterior vascular prolongation.

Remarks: Encrusting appearance of colony, absence of transverse muscles and presence of ca. 10 well developed longitudinal muscles on each side of the thorax, much more (ca. 40) inner longitudinal vessels and the situation of the stomach in the anterior half of the abdomen are the characteristics of the present new species differentiating it from *S. grandis*.

Loc.: 29° 08–12′N×126° 10–22′E, 93 m. July 10, 1954.
Sp. No.: Type 152.

4. *Pyrosoma atlanticum atlanticum* (Peron), 1804

A 75 mm long colony; the anterior part ca. 10 mm and the posterior part 19 mm in width and rather compressed being ca. 8 mm in thickness. Two zooids were dissected; they were respectively provided with: ···

27 gill slits ····· 15 inner longitudinal vessels
ca. 25 gill slits ····· 14–15 inner longitudinal vessels } 9 dorsal languets.

Loc.: 33°28–32.5′N×129°05–11′E, 108–0 m. June 29, 1954.
Sp. No.: Asc. 55.

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2. A New Species of *Distaplia* (*D. coronata* n. sp.) from the Japanese Waters.

(Pl. XII; Text-fig. 2)

Prof. H. Oka of Tokyo University of Education sent me a colony of a compound ascidian which was grown on a submerged slide glass at Simoda Marine Biological Laboratory and fixed finely in formalin after cocainization. At a glance I found immediately that this ascidian should be a new form. And after careful examination, it is proved that this new form belongs to the genus *Distaplia*. The colony is attached to the slide glass by wide and flat creeping stolons assuming the form of a complex configuration as shown in Pl. XII fig. A. It contains merely a cormidium which consists of the corona, 7 mm in diameter and 5 mm high, and the peduncle 4 mm in diameter and 3.5 mm in height. The corona comprises a single system which is composed of a dozen zooids surrounding a common cloacal aperture at the centre and situated perpendicularly with their ventral sides towards the periphery. The margin of the common cloacal aperture is divided into about 10 lobules. The peripheral margin of the upper surface of the corona is provided with a dozen languets-like protuberances placed one at the ventral mid-line of each zooid. Corona contains thorases of zooids and the distal half of the peduncle contains abdomens. The colony of the paratype which was also grown on the slide glass at Simoda, fixed on Sept. 6, 1952 and preserved in the Zoological Institute of Tokyo University of Education has 5 cormidia consisting respectively of 6, 7, 12, 12 and 13 zooids. Both the type and the paratype are practically colourless throughout the whole colony in preservation in formalin, only faintly tinted grayish green at zooids. The corona nearly transparent, while the peduncle and stolons are translucent. A greenish mass is found in the stolon of the type specimen. Mr. H. Watanabe of Tokyo University of Education sent me kindly a sketch of this ascidian coloured carefully as in its living state. This sketch was made on Nov. 9, 1954 at Simoda Marine Biological Laboratory and shows the following colouration: ··· The upper surface of the corona faintly yellowish and sprincled sparsely with pinkish dots. The yellow pigments are found along the tentacular ring and especially densely around the dorsal ganglion. The lateral side of the corona is faintly brownish and dotted with pinkish, yellowish and whitish pigment spots, the last ones of which are found densely on the branchial lobes. The peduncle is pinkish as a whole and sprinkled with white spots.

Zooid: Thorax up to 3.4 mm and abdomen 2.3 mm in length. Neck region narrowed considerably. A pair of vascular prolongations are protruded from the left side of the intestinal loop, where the heart is situated. The area near the apex of the testicular mass seems to be prolonged also in a form of the vascular canal, although I could not trace this structure completely, because it was torn in every examined zooid. The incubatory pouch was not found in any zooid.

Thorax: Branchial aperture 6-lobed; the dorsal-most lobe is small, while the ventral-most one is much larger than others. Atrial aperture a huge opening and with a large atrial languet at the anterior end, the tip of which is simply acute or trifid as shown in Pl. XII fig. D. Twenty-five to thirty muscles on each side of the thorax; muscles in the anterior half are nearly transverse, while those in the posterior half are quite oblique. The neighbourhood of the dorsal ganglion is devoid of muscles. Muscles around the branchial aperture are all circular. A pair of the longitudinal muscles are running along the dorsal mid-line of the branchial sac and proceed posteriorly onto the left side of the abdomen and finally enter the vascular prolongations one in each of the two appendages; this musculature seems to play as the retractor in this form. Stigmata in each of 4 rows are as follows:

1st row	20–22	3rd row	18–19
2nd row	20	4th row	15–17

The ventral-most stigma in each row is much smaller than others. Stigmata of the first and the fourth rows diminish the length ventrally. Parastigmatic vessels distinct. Dorsal languets remarkable and displaced to the left from the dorsal mid-line. Tentacles 12, large and small ones alternate regularly. Ciliated groove is a roundish orifice.

Abdomen: Stomach is roughly elliptical in shape, not so large as in *Dist. dubia* (OKA) and provided with ca. 16 longitudinal plications on the right side, plications on the left side are rather irregular. Hind-stomach is not differentiated superficially, although this portion can be distinguished from the stomach proper by the complete absence of longitudinal plications. Mid-intestinal region is also indistinct, but it is discernible clearly when the preparation of the intestinal loop is examined in the light field under the microscope. This part occupies the posterior end of the intestinal loop. Anus bilobed and situated on the level of the 3rd transverse vessel. Testis situated on the right posterior side of the intestinal loop, its posterior half being protruded posteriorly out of the abdomen. Follicles generally 8 in number, each elongate in form and may rarely be branched. Ovary not found in any zooid.

Larva: Five well developed embryos were measured. Trunk elliptical, 1.29–1.45 mm (1.38 mm on average) in length, width/length 0.49–0.59 (0.55 on average). Three cup-shaped attachment processes arranged in a triangle. The ventral-most process has two bulbiform swellings at the base, while others are provided each with only one bulb. There is a considerably wide space between the bases of the attachment processes and the zooid which is situated slightly posterior to the middle of the trunk and vertically. Two pigment flecks of the sensory organ situated dorso-ventrally. Anus situated slightly on the left side and the dorsal ganglion and the sensory organ are displaced slightly to the right from the dorsal mid-line. Larval test frothy.

Remarks: The corona-like cormidium consisting of a single system and nearly

transparent appearance of the colony are the most striking characteristics of the present new species. The thorax comparatively larger than in other species and thoracic muscles running transversely or obliquely can be also accepted as characteristics of the new species. Larva is narrower than in *Dist. dubia,* in which width /length is 0.67 in an examined specimen (1.2 mm long). In larva of *Dist. dubia,*

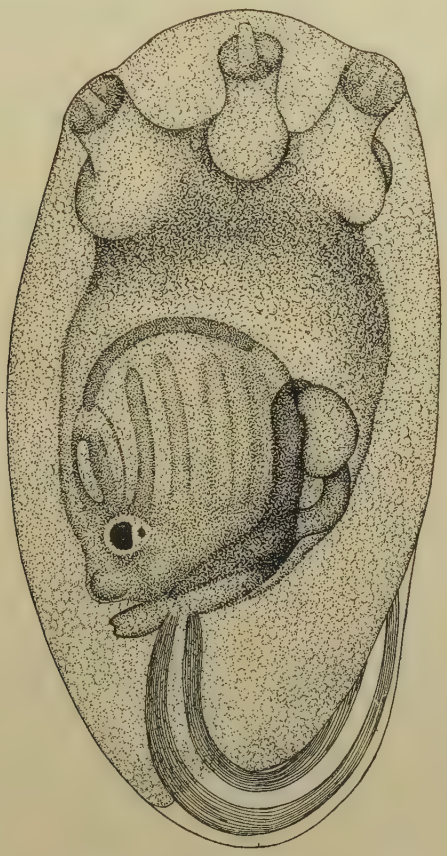


Fig. 2. *Distaplia coronata* n. sp.
Embryo from right side, ×73.

each attachment process has two bulbiform basal swellings. The situation of the zooid in the trunk of the larva in this new species closely resembles that in *Dist.* sp. aff. *dubia* described in "Ascidians of Sagami Bay (p. 207, Pl. X figs. 5–7)".

Lastly I wish to express here my hearty thanks to Prof. H. Oka and Mr. H. Watanabe for their kindness in offering me precious materials.

Sp. No.: Type 153.

3. Atrial Tentacles of *Styela clava* HERDMAN.

(Text-fig. 3)

I was obliged to re-examine closely some specimens of *Styela clava* HERDMAN when I was consulting about the identity of this species with *Styela mammiculata* CARLISLE recently reported by the author of the species from Plymouth Sound. On this problem I came to the conclusion that both species are quite identical with each other. Besides I found at the first time that the atrial tentacles of *St. clava* are very peculiar in their arrangement. Tentacles are fine and very numerous; they are arranged densely in two rows as shown in Fig. 3.

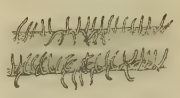


Fig. 3. *Styela clava* HERDMAN. Atrial tentacles, magnified.

4. Ascidians Fouling the Pearl Oysters in the Arafura Sea.

(Pls. XIII & XIV; Text-figs. 4–5)

I had a chance to examine a few ascidians which were taken up by members of the Tôkai Regional Fisheries Research Laboratory as remarkable fouling animals of the pearl oyster, *Pteria* (*Pinctada*) *maxima* (JAMESON), in the Arafura Sea. They consist of:

Polycarpa longiformis TOKIOKA ····· 1 individual
Microcosmus helleri HERDMAN ····· 2 individuals

Besides, I found small colonies or individuals of the following three species attached to the surface of *Microcosmus*.

Didemnum (*Didemnum*) *moseleyi* (HERDMAN)
Polyandrocarpa (*Eusynstyela*) *latericius* (SLUITER)
Styela partita (STIMPSON)

In the following, I wish to give some notes on these species. Before going further, I express here my hearty thanks to Messrs. TAKEMURA and OKUTANI for their kindness in giving me the chance to examine the specimens.

1. *Didemnum* (*Didemnum*) *moseleyi* (HERDMAN), 1886

(Pl. XIV, Figs. R–S)

More than 10 small whitish colonies, the largest one of which is 10 mm × 6 mm in extent. They are all less than 1 mm in thickness. Spicules usually less than 49μ in diameter (57μ in the maximum diameter); rays of moderate length, bluntly pointed at the tip and 8–9 in number on the equatorial plane. Spicules are distributed densely and evenly throughout the colony from the surface to the bottom. The surface shows partially a sort of the granulated appearance. Average distance between zooids is

510μ. Thorases are all contracted strongly, 260–310μ (280μ on average) in length in a contracted state; abdomen ca. 400μ in length. The length of retractile muscles 44–121% of that of the contracted thorax, being 72% on average. Testicular follicle 1. The proximal portion of vas deferens coils 5 times in an examined zooid. Trunk of larva 550μ in length, width/length 0.63. Two sensory pigment flecks arranged antero-posteriorly.

Sp. No.: Rare 167.

2. *Polyandrocarpa* (*Eusynstyela*) *latericius* (Sluiter), 1904

(Pl. XIII, Figs. F & G)

A small colony, 15 mm long and 1 mm thick; zooids less than 4.5 mm in length. Both apertures respectively subterminal. Common test purplish, test covering the zooid is yellowish white with a large reddish orange pigment fleck on each lateral side. The dome-like swelling around each aperture has 4 thick reddish orange colour bands radiating from the aperture, the branchal aperture issues besides 4 thinner bands of the same colour. Mantle thin, about a dozen small elongate endocarps on each side of the inner surface. Atrial tentacles could not be detected on the present strongly contracted specimen. About 12 regular stigmatal rows and 1–3 irregular ones, inner longitudinal vessels are arranged for instance D 0 (7) 0 (4) 1 (7) 1 (5) 1 V on the left side in an examined zooid. Parastigmatic vessels are found on anterior large stigmata. Stigmata in a mesh less than 5. Tentacles 11 in an examined individual, consist of large and small ones. Ciliated groove (Pl. XIII fig. G) a longitudinal slit. The anterior end of the intestinal loop reaches two-thirds of the body length in a slightly contracted state. The cardiac end of the stomach situated near the posterior margin of the branchial sac and the pyloric end situated near the middle of the body. Fourteen to fifteen longitudinal plications on the stomach, pyloric coecum large and distinct. Anus opens near the opening of the oesophagus at the posterior end of the branchial sac and plainly margined. Gonad not yet formed.

Sp. No.: Rare 165.

3. *Polycarpa longiformis* Tokioka, 1952

(Pl. XIII, Figs. H & I; Text-fig. 4)

Body elongate and attached to the substratum by the posterior end, 53 mm in length excluding siphons of considerable length and 17 mm wide; it is compressed laterally and 7 mm in thickness. The atrial siphon longer than the branchial. Both apertures are 4-lobed. Test grayish white in colour, hard cartilaginous in consistency and ca. 2 mm in thickness, considerably thicker in the posterior portion; the inner surface whitish. The surface naturally smooth and free from foreign matters,

although a few irregular faint grooves are produced by contraction. Mantle delicate and pale yellowish brown in colour. Endocarps small and rather numerous, those in the posterior third and along the side of the endostyle in the posterior half of the body on the left side are larger than others. On the right side, larger endocarps occupy the ventro-posterior part of the body. Atrial velum indiscernible. Branchial sac and alimentary canal are completely eviscerated. Tentacles ca. 40 excluding minute ones, comprise large and small ones. Ciliated groove ↄ-shaped with both terminals curled in. Seventeen gonads on the right and 21 ones on the left, besides 11 gonads were found in the mantle sac being quite detached from the wall. Gonads are 2–2.2 mm in length in larger ones.

Sp. No.: Rare 164.

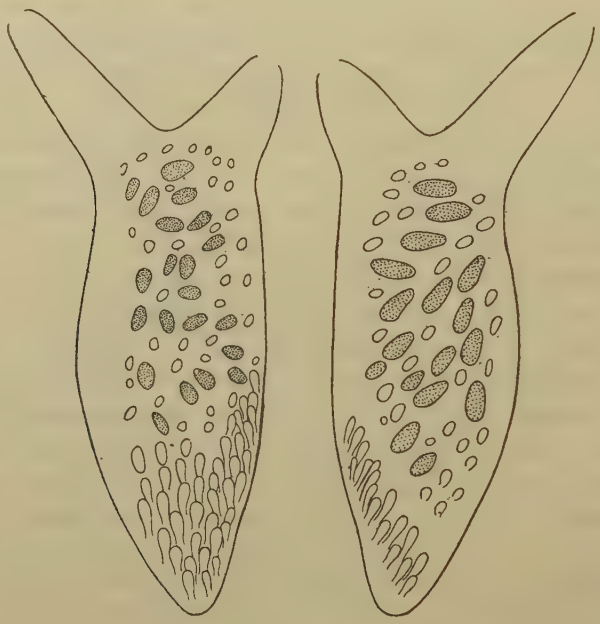


Fig. 4. *Polycarpa longiformis* TOKIOKA.

Left ··· Left half of mantle body, from inside.
Right ··· Right half of mantle body, from inside.

4. *Styela partita* (STIMPSON), 1852

(Pl. XIII, Figs. J & K; Pl. XIV, Fig. Q; Text-fig. 5)

A 9 mm long×6 mm wide specimen attached to the test of *Microcosmus* by its whole left side. The body is roughly oval in shape, branchial aperture subterminal and atrial aperture situated near it, both apertures are sessile and 4-lobed. Test leathery, yellowish brown in colour, with a reddish orange tint in a considerably wide

area surrounding the apertures. This colouration is seen through on the inner surface of the test. The surface is wrinkled irregularly in preservation, test on the left attachment surface extremely thin. Mantle whitish yellow, extremely delicate and is provided with a number of endocarps on the inner surface. Fine tentacles (Pl. XIV fig. Q) found densely on the atrial velum.

Branchial sac: Inner longitudinal vessels are arranged:
Left D. 3 (11) 4 (7) 3 (13) 3 (7) 2 V.
Right D. 6 (11) 3 (11) 3 (11) 1 (6) 1 V.

Transverse vessels arranged ··· thick *p* thin *p* thick ··· where *p* represents the parastigmatic vessels. Stigmata very long, 2–3 ones in a mesh. Tentacles less than 20? Ciliated groove simply U-shaped.

Alimentary system: The axis of the second intestinal loop passes far in front of the cardiac end of the stomach which is elliptical in shape, longer than a half of the ventral branch of the first intestinal loop and provided with ca. 15 longitudinal plications on the right surface and an indistinct swelling at the pyloric end. Seven endocarps in the first intestinal loop. Anal margin with ca. 15 lobules. Gonad not yet developed.

Remarks: This specimen may be accepted safely as an immature *St. partita*, because the arrangement of the alimentary canal resembles closely that of the typical individuals of that species. The swollen appearance of the intestine is probably an unnatural deformation.

Sp. No.: Rare 166.

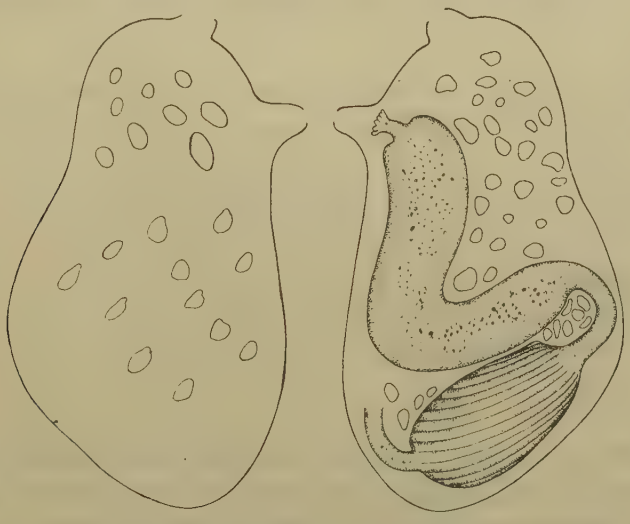


Fig. 5. *Styela partita* (Stimpson).
Left ··· Right half of mantle body, from inside.
Right ··· Left half of mantle body, from inside.

5. *Microcosmus helleri* Herdman, 1881

(Pl. XIII, Figs. A–E; Pl. XIV, Figs. L–P)

The body roughly oval in shape and compressed laterally, with protruded short siphons and attached to the substratum by the posterior end of the body or by the prolongation of the test at the rear end of the body. The animals lie with their right or left sides beneath. Branchial siphon terminal or subterminal, the anterior base of atrial siphon at the middle of the body. Two specimens respectively 67 mm (long) × 40 mm (wide) × 24 mm (thick) and 68 mm (l) × 45 mm (w) × 23 mm (t) in measurement. Test hard leathery, ca. 2 mm in thickness and whitish yellow to yellowish brown in colour; the inner surface pearly whitish and glistening. The surface is irregularly wrinkled and with hydrozoans, didemnids and other small solitary ascidians adhered there. The test is penetrated by bivalves, *Musculus* sp., especially remarkably around the apertures. Mantle whitish yellow and of moderate thickness. No endocarps on the inner surface of the mantle. There are fine tentacle-like protuberances (ca. 180μ in length) on the inner surface of the distal part of siphons.

A 6 mm long individual found on the larger specimen (Pl. XIII fig. D) nearly elliptical in outline and attached to the test by the ventral side slightly inclined to the left side. Test milky white with slight purplish hue and produces several outgrowths from the periphery. Branchial aperture terminal and the atrial subterminal, both apertures nearly sessile. Mantle whitish and translucent. In a 2.5 mm long individual, test milky white in colour and with a few reddish orange spots on the dorsal side, mantle yellowish white; branchial aperture near the terminal end and the anterior base of the atrial siphon at the middle of the body, both siphons of a considerable length.

Branchial sac: Six folds on each side, although the ventral-most one (VI) in the 2.5 mm long individual is indistinct.

68 mm long individual:

Left D. 4 (44) 2 (30) 3 (33) 4 (29) 4 (22) 3 (17) 1 V

Right D. 4 (38) 2 (29) 4 (32) 3 (29) 4 (25) 4 (23) 1 V.

67 mm long individual:

Left D. 3 (34) 3 (27) 4 (25) 4 (24) 3 (20) 2 (16) 1 V.

Right D. 3 (33) 1 (26) 3 (28) 2 (26) 4 (22) 3 (20) 1 V.

6 mm long individual:

Right D. 1 (11) 0 (8) 0 (11) 0 (11) 1 (9) 0 (7) 0 V.

Transverse vessels arranged as ··· 133323331 ··· in the order of the thickness and with parastigmatic vessels in large specimens, while as ··· 1 p 2 p 1 ··· in the 6 mm long individual, here p represents parastigmatic vessels. Usually 6–8 stigmata (15 in the maximum) in a mesh in larger specimens. Tentacles in large specimens 13–16, larger and smaller ones situated roughly alternately, besides minute ones at some intervals;

branches in 4 orders. In the 6 mm long individual they are ca. 10 comprising large and small ones; branches in 2 orders. Ciliated groove simple U-shaped in smaller specimens.

Alimentary system: The anterior margin of the intestinal loop reaches near the base of the branchial siphon. Several endocarps along the anterior end of the loop, besides one or two are found at other parts of the loop in larger specimens. Liver brown, yellowish brown, yellowish or even whitish in some parts.

Gonad: Two (in larger specimens)–three (6 mm long specimen) genital capsules on the right and 3 on the left side. No capsule developed in the 2.5 mm long individual. Capsules colourless to grayish brown.

Sp. No.: Rare 163.

EXPLANATION OF PLATES XI–XIV

Plate XI

Figs. A–E. *Syndiazona chinensis* n. sp.
- A ··· Zooid, ×3.3.
- B ··· Thorax, right side; enlarged.
- C ··· Abdomen, enlarged.
- D ··· A part of tentacular rings, magnified.
- E ··· Dorsal tubercle, magnified.

Figs. F–G. *Didemnum* (*Didemnum*) *apersum* Tokioka.
- F ··· A part of the colony surface, ×23.
- G ··· Calcareous spicules, ×630.

Plate XII

Figs. A–D. *Distaplia coronata* n. sp.
- A ··· Type colony, enlarged.
- B ··· Zooid, right side, ×23. Thoracic muscles are shown in detail.
- C ··· Zooid, left side, ×23. Thoracic muscles omitted from the figuer.
- D ··· Tip of a trifid atrial languet, magnified.

Plate XIII

Figs. A–E. *Microcosmus helleri* Herdman.
- A ··· 68 mm long individual, left side.
- B, C ··· Ciliated grooves of 68 and 67 mm long individuals, enlarged.
- D ··· 6 mm long individual.

E ··· Ciliated groove of 6 mm long individual.

Figs. F–G. *Polyandrocarpa* (*Eusynstyela*) *latericius* (Sluiter).

F ··· A zooid, dorsal; enlarged.

G ··· Ciliated groove, magnified.

Figs. H–I. *Polycarpa longiformis* Tokioka.

H ··· 53 mm long individual, right side.

I ··· Ciliated groove, enlarged.

Figs. J–K. *Styela partita* (Stimpson).

J ··· 9 mm long individual.

K ··· Ciliated groove, magnified.

Plate XIV

Figs. L–P. *Microcosmus helleri* Herdman.

L ··· Right half of mantle body of 68 mm long individual, from inside.

M ··· Left half of the same individual, from inside.

N ··· Tentacle-like protuberances on the inner surface at the distal part of siphons, ×73.

O ··· Right half of mantle body of 6 mm long individual, from inside.

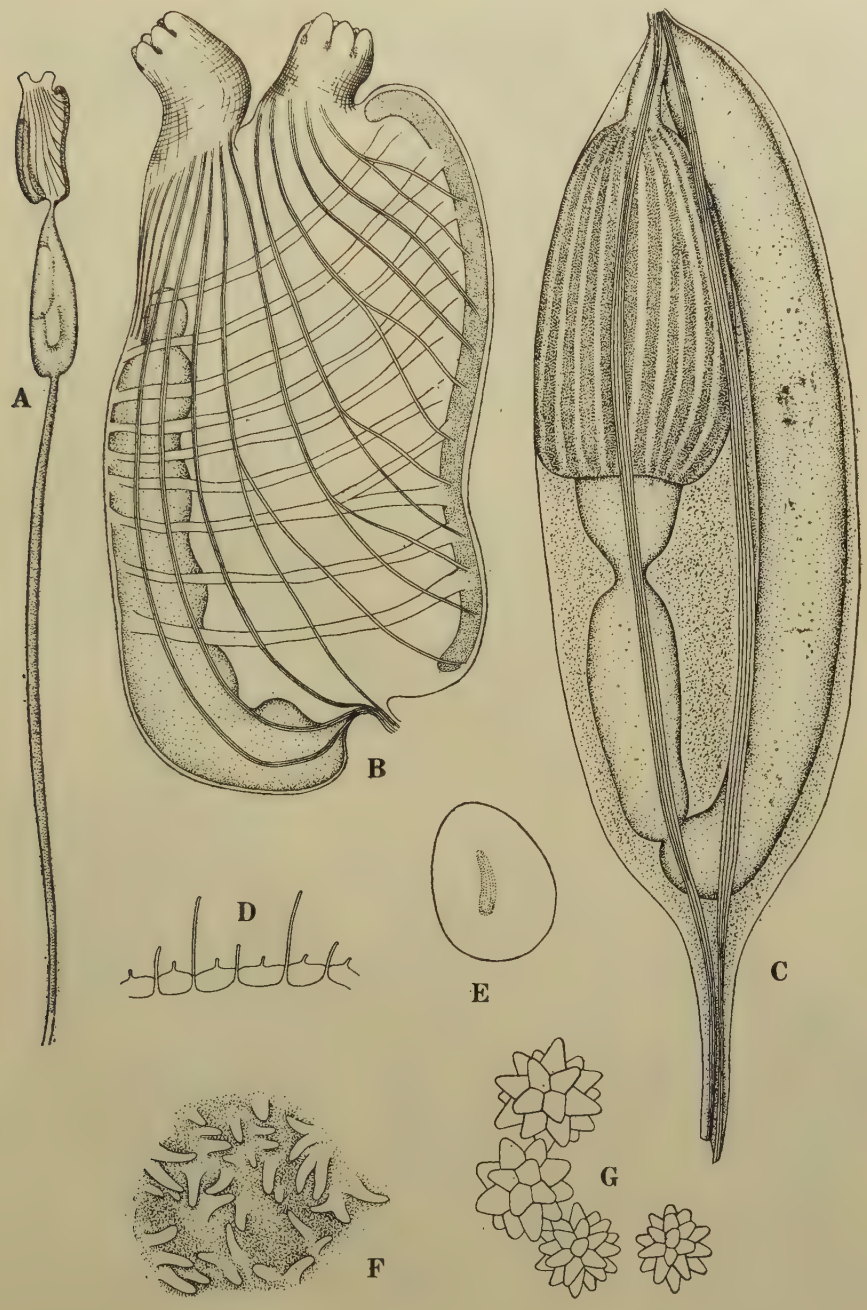
P ··· Left half of the same individual, from inside.

Fig. Q. *Styela partita* (Stimpson), atrial tentacles, ×73.

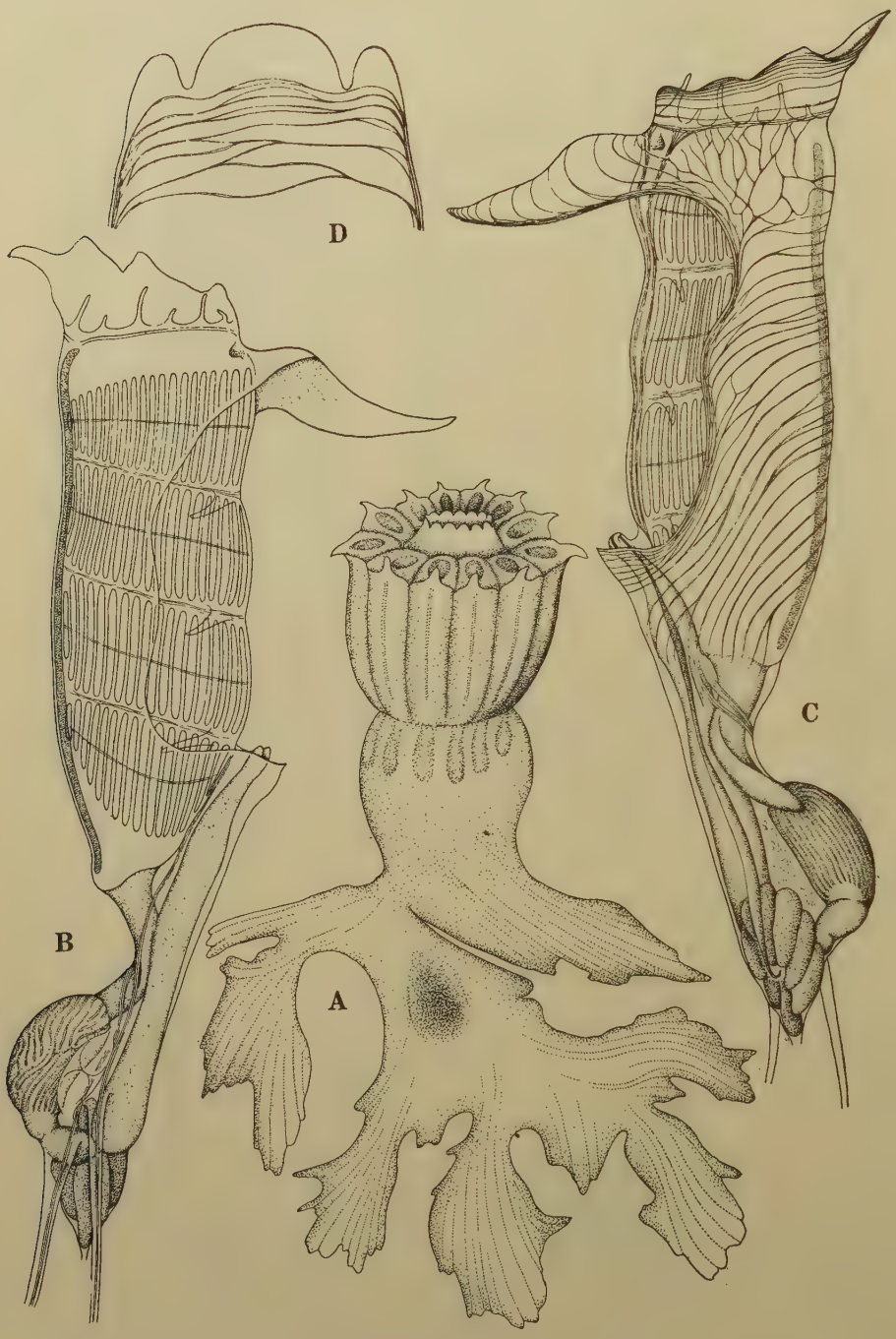
Figs. R–S. *Didemnum* (*Didemnum*) *moseleyi* (Herdman).

R ··· Calcareous spicules, ×630.

S ··· Embryo from right side, ×73.



T. Tokioka: Contributions to Japanese Ascidian Fauna, XI.



T. Tokioka: Contributions to Japanese Ascidian Fauna, XI.

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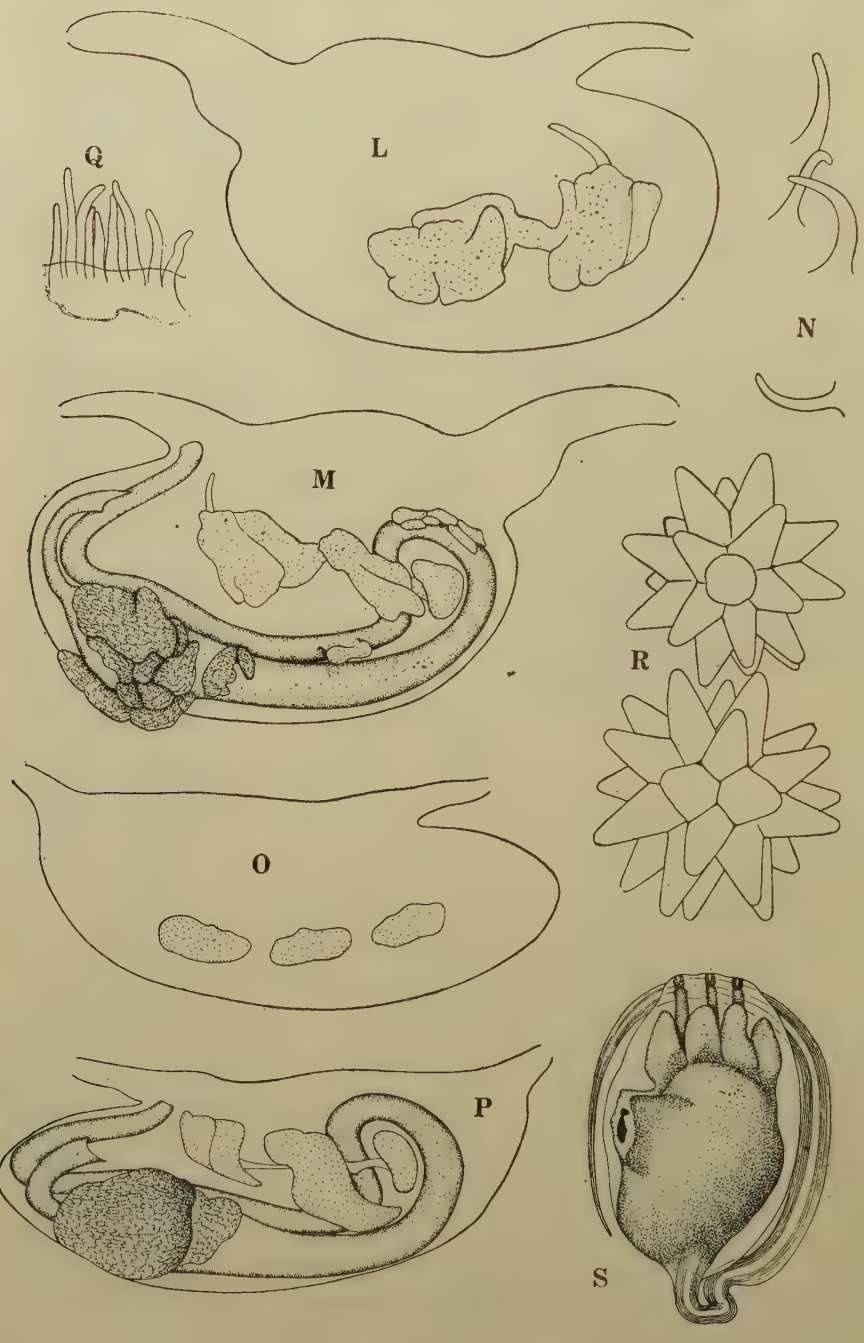


T. Tokioka: Contributions to Japanese Ascidian Fauna, XI.

ON SOME PLANKTON ANIMALS COLLECTED BY THE SYUNKOTU-MARU IN MAY-JUNE 1954

I. CHAETOGNATHA[1)]

TAKASI TOKIOKA
Seto Marine Biological Laboratory, Sirahama

With 4 Text-figures and a map

The good fortune was bestowed on me by courtesy of Mr. H. MAÉDA of the Simonoseki College of Fisheries to examine plankton samples collected by the Syunkotu-Maru during her surveying voyage around Bikini Island in the Marshall Islands for the purpose to investigate the influences of a series of experiments of atomic or hydrogen bombs upon the water of the surrounding sea and on the pelagic fauna and flora in this area. The samples were hauled vertically from 150 m to surface by fish larva net with the mouth 1 m in diameter, at 25 stations during the period from May 21 to June 29, 1954.

Sixteen species of chaetognaths were found in these samples in the following proportion.

Species	Individual number	Percentage
1. *Sagitta hexaptera*	1058	11
2. *Sagitta lyra*	4	
3. *Sagitta enflata*	4091	41
4. *Sagitta bipunctata*	187	2
5. *Sagitta ferox*	50	0.5
6. *Sagitta robusta*	206	2
7. *Sagitta pulchra*	1	
8. *Sagitta serratodentata pacifica*	2586	26
9. *Sagitta serratodentata atlantica* f. *pseudoserratodentata*	32	
10. *Sagitta neglecta*	2	
11. *Sagitta regularis*	51	0.5
12. *Sagitta minima*	41	
13. *Sagitta decipiens*	1	
14. *Pterosagitta draco*	1265	13
15. *Krohnitta subtilis*	39	

1) Contributions from the Seto Marine Biological Laboratory, No. 255.

16.	*Krohnitta pacifica*	146	1
17.	Damaged individuals or juv.	252	3
		10012	

Occurrence of these species at each station is shown in detail in the table at the end of this article. Dominant species in the present material are *Sag. enflata*, *Sag. serratodentata pacifica*, *Pterosagitta draco* and *Sag. hexaptera*. *Sag. bipunctata* and *Sag. robusta* follow these four species, although they are much less in number. *Krohnitta pacifica*, *Sag. ferox*, *Sag. regularis* and *Krohnitta subtilis* are rather rare. And it is a noticeable fact that *Sag. bedoti* is quite absent in this material from the tropical oceanic waters of the Western Pacific.

Distribution

Total amount: At stations in the South Equatorial Current, south from 3°N or thereabout, the total number of chaetognaths in each haul was much larger than at stations in the Equatorial Counter-Current and the North Equatorial Current; no clear quantitative difference was found between hauls from stations in the North Equatorial Current and those from stations in the Equatorial Counter-Current. The number of species was not proportional to the total amount. However, as each sample was not hauled accurately for the quantitative investigation, I wish hereafter to cease to refer to the total amount and go further on problems about the proportional composition of these samples.

Proportional composition: The proportional composition about each three of the four chief species, *Sag. enflata* (E), *Sagitta serratodentata pacifica* (S), *Pterosag. draco* (P) and *Sag. hexaptera* (H).

St. 18 is excluded from this consideration, because individuals in the sample from this station were very few in number and more or less mutilated and thus the sample at this station could not be considered to be hauled in normal condition.

1. Diagram EPS (Fig. 1). The following four points are noticeable.
   a) St. 2 is characterized by unusual predominance of S.
   b) Stations in the South Equatorial Current, south from 3°N, are located in the apical quater beyond 50 % of E.
   c) Stations in the Equatorial Counter-Current, south from 10°N or thereabout, are situated in the section upper than 40 % of E.
   d) St. 1 is ramarkable in the predominance of P.
2. Diagram EHS (Fig. 2).
   a) St. 2 is characterized by unusual predominance of S.
   b) Stations in the South Equatorial Current, south from 3°N, are situated in the quater upper than 50 % of E.
   c) E is dominant at most stations in the Equatorial Counter-Current, south from 10°N, attaining to 40–50 %, but here H increases gradually. The increase of H is considerable at stations north from 8°N.

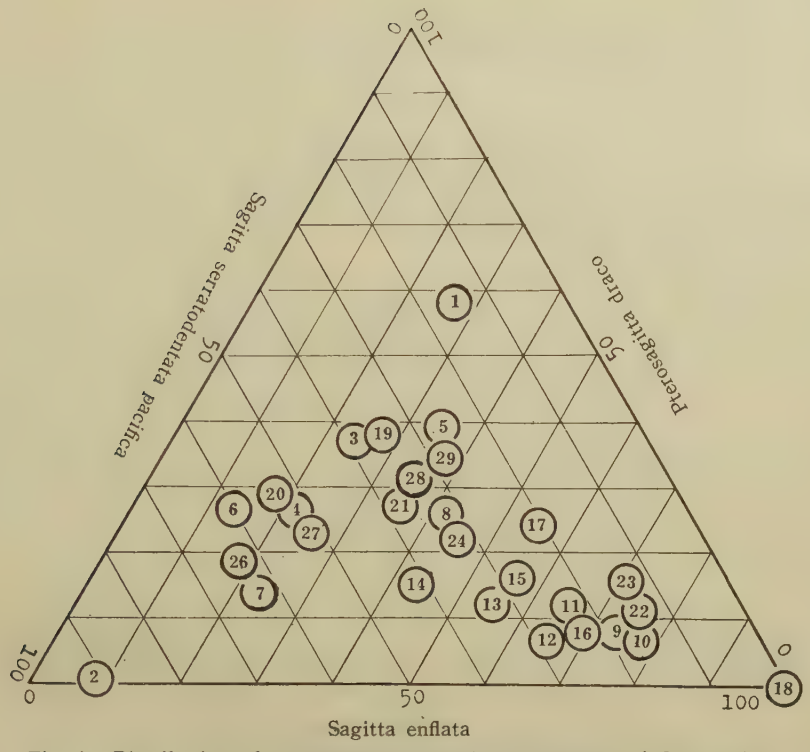


Fig. 1. Distribution of stations shown by the percentages of *Sag. enflata*, *Pterosag. draco* and *Sag. serratodentata pacifica*.

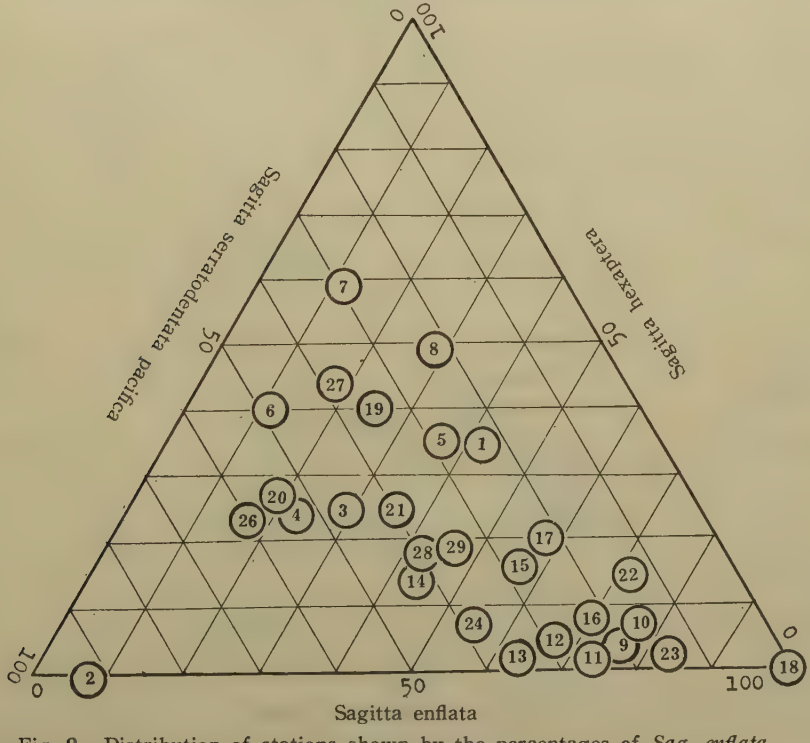


Fig. 2. Distribution of stations shown by the percentages of *Sag. enflata*, *Sag. hexaptera* and *Sag. serratodentata pacifica*.

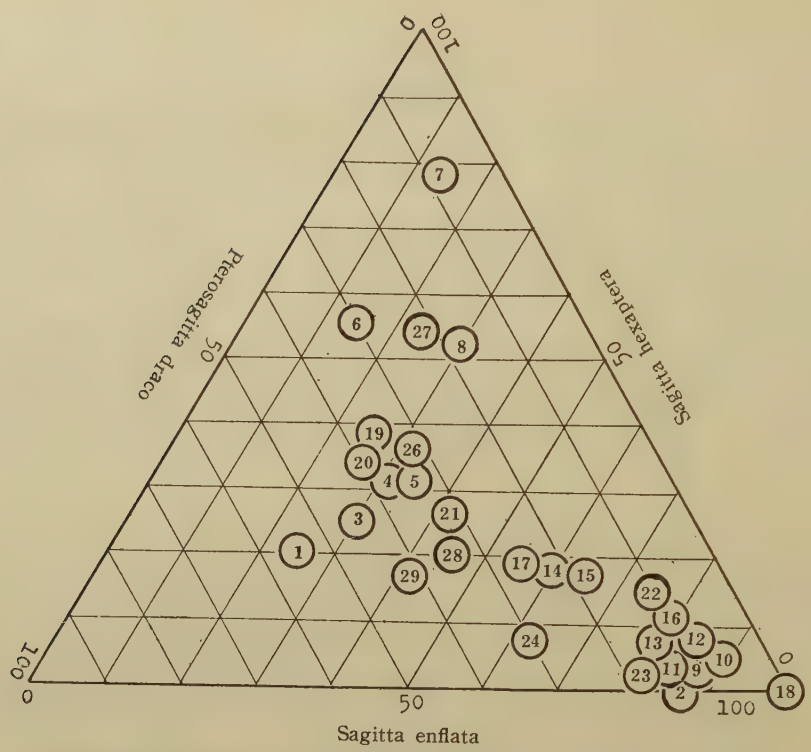


Fig. 3. Distribution of stations shown by the percentages of *Sag. enflata*, *Sag. hexaptera* and *Pterosag. draco*.

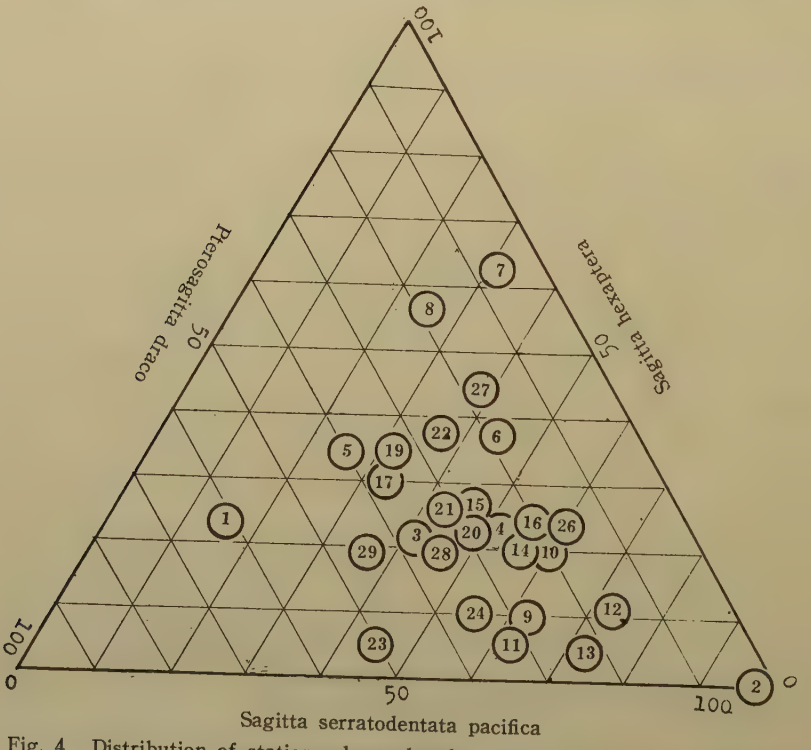


Fig. 4. Distribution of stations shown by the percentages of *Sag. serratodentata pacifica*, *Sag. hexaptera* and *Pterosag. draco*.

3. Diagram EHP (Fig. 3).
   a) E shows high values at stations south from 3°N.
   b) E is high also at stations in the Equatorial Counter-Current, mostly reaching 50 % or beyond it, but here H increases considerably, especially at stations between 8°N and 14°N.
4. Diagram SHP (Fig. 4).
   a) St. 2 is remarkable in the predominance of S.
   b) St. 1 is noticeable by abundance of P.
   c) H is very low at stations in the South Equatorial Current.
   d) H is especially high at Sts. 7 and 8.

Throughout the tendencies shown by diagrams given above, the following two features may be accepted as of the general significance.

   a) The proportion of *Sag. enflata* was higher at stations in the Equatorial Counter-Current than at those in the North Equatorial Current, and especially remarkable at stations in the South Equatorial Current.
   b) The proportion of *Sag. hexaptera* was low at stations in the South Equatorial Current, but increased at stations in the Equatorial Counter-Current and much more in the North Equatorial Current. The highest values were observed at Sts. 7 and 8 during the present survey.

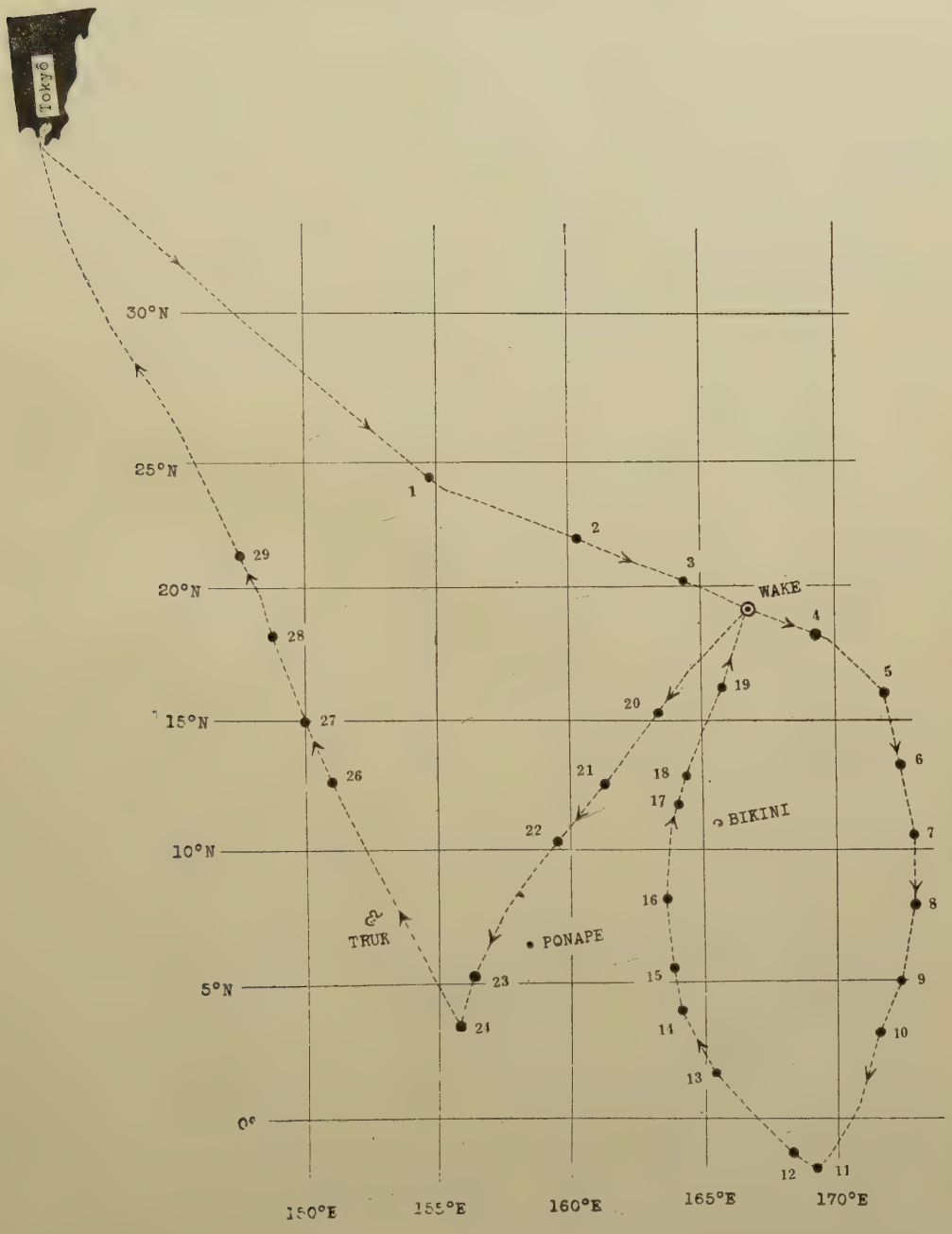
High P at St. 1 and high S at St. 2 are also evident features. These two are, however, not considered to be of the general significance, but they are merely examples of the sporadic unevenness in the distribution of these animals. The two features, above-mentioned a and b, are very evident, although it must be noticed here that there was no discontinuity-line in the distribution of *Sag. enflata* and *Sag. hexaptera* and that it is quite uncertain whether such distributions are observable constantly or merely temporarily. Besides all, the occurrence of *Sag. minima* merely at Sts. 1 and 29, both north from 21°N, seems to be a noteworthy record.

Lastly I express here my hearty thanks to Mr. H. Maéda for his kindness in offering me the chance to examine the present precious material.

Station	Date	Situation	Time
1	21 V	23°58′ N 154°40′ E	5.00–7.15
2	22 V	21°55′ N 160°00′ E	19.03–20.46
3	24 V	19°53′ N 164°00′ E	9.09–10.25
4	29 V	18°12′ N 169°43′ E	10.00–11.53
5	30 V	16°02′ N 171°50′ E	11.00–12.32
6	31 V	13°51′ N 172°56′ E	4.00–5.38

Station	Date	Situation	Time
7	1 VI	10°44′ N 173°03′ E	4.00–6.00
8	2 VI	8°02′ N 173°02′ E	3.15–4.42
9	3 VI	5°03.5′ N 172°59′ E	9.45–14.00
10	4 VI	3°01′ N 171°59′ E	4.00–12.44
11	6 VI	2°21′ N 169°56′ E	4.00–17.40
12	7 VI	1°15′ S 168°05′ E	4.00–6.00
13	8 VI	1°04′ N 165°47′ E	4.00–6.15
14	9 VI	3°55′ N 163°52′ E	4.00–11.00
15	10 VI	5°44′ N 163°58′ E	4.17–7.30
16	11 VI	8°43′ N 164°01′ E	8.00–10.05
17	12 VI	10°55′ N 163°51′ E	4.00–7.58
18	13 VI	13°23′ N 164°25′ E	8.00–10.39
19	14 VI	15°57′ N 165°22′ E	4.45–7.15
20	19 VI	15°03′ N 163°15′ E	4.00–5.55
21	20 VI	12°42′ N 161°26′ E	8.00–10.30
22	21 VI	10°21′ N 159°35′ E	7.15–9.33
23	23 VI	5°03′ N 155°53′ E	7.47–13.00
24	24 VI	3°24.5′ N 155°34′ E	8.00–10.25
26	27 VI	12°00′ N 151°10′ E	4.38–5.30
27	28 VI	14°46′ N 149°56′ E	0.20–1.22
28	29 VI	18°00′ N 148°38.5′ E	
29	29 VI	21°00′ N 147°21′ E	21.56–22.45

Station Map of the Syunkotu-Maru Survey in May—June 1951.



Species \ Stations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sagitta hexaptera	28 (13)	1	13 (15)	5 (17)	45 (23)	76 (30)	47 (49)	49 (34)	11 (3)	55 (5)	19 (2)	33 (4)	30 (2)	58 (11)	4 (11)	14 (6)
Sagitta lyra	4 (2)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sagitta enflata	35 (16)	21 (6)	15 (18)	5 (17)	48 (24)	19 (8)	9 (9)	30 (20)	245 (69)	683 (68)	504 (58)	548 (58)	718 (54)	180 (35)	14 (38)	118 (54)
Sagitta bipunctata	18 (8)	44 (13)	—	2 (7)	7 (4)	9 (4)	4 (5)	17 (12)	1		3	2	2	4 (1)		4 (2)
Sagitta ferox	1	—	—	—	—	—	—	—	—	—	12 (1)	21 (2)	3	—	—	2 (1)
Sagitta robusta	—	8 (2)	3 (4)	—	5 (2)	6 (2)	5 (5)	1 (1)	5 (2)	6 (1)	8 (1)	23 (2)	6	15 (3)	3 (8)	11 (5)
Sagitta pulchra	—	—	—	—	—	—	—	—	—	—	—	—	—		—	
Sagitta serratodentata pacifica	19 (9)	244 (70)	24 (29)	12 (40)	35 (18)	89 (36)	24 (25)	22 (15)	62 (18)	150 (15)	179 (21)	239 (25)	416 (31)	169 (33)	7 (19)	37 (17)
Sagitta serratodentata atlantica f. *pseudoserratodentata*	1	—	—	—	—	—	—	—	—	—	—	—	—	—		
Sagitta neglecta	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Sagitta regularis	—	—	—	—	1	—	1 (1)	1 (1)	1	5 (1)	14 (2)	7 (1)	1	1	1 (3)	2 (1)
Sagitta minima	17 (8)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sagitta decipiens	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1 (3)	
Pterosagitta draco	77 (35)	2 (1)	23 (27)	6 (20)	54 (27)	40 (16)	4 (5)	17 (12)	28 (8)	55 (5)	100 (11)	57 (6)	136 (10)	61 (12)	4 (11)	15 (7)
Krohnitta subtilis	14 (6)	—	2 (2)	—	—	—	—	—	—	—	—	—	—	6 (1)	—	—
Krohnitta pacifica	4 (2)	24 (7)	1 (1)	—	—	—	—	—	—	25 (2)	15 (2)	17 (2)	2	—	1 (3)	2 (1)
Damaged individuals or juv.	2 (1)	3 (1)	3 (4)	—	5 (2)	11 (4)	1 (1)	7 (7)	1	28 (3)	19 (2)	4	10 (1)	22 (4)	2 (5)	14 (6)
Total individual number	220	347	84	30	200	250	95	144	354	1007	873	951	1324	516	37	220

17	18	19	20	21	22	23	24	26	27	28	29	Frequency of occurrence	Mean individual number per a haul
32 (14)	—	66 (27)	122 (19)	33 (17)	42 (11)	1 (1)	8 (5)	18 (16)	176 (32)	33 (12)	39 (9)	27/28	39
—	—	—	—	—	—	—	—	—	—	—	—	1/28	4
91 (41)	8 (66)	41 (17)	100 (15)	47 (25	235 59)	61 (51)	56 (38)	14 (13)	75 (14)	78 (28)	93 (21)	28/28	146
3 (1)	2 (17)	8 (3)	3	5 (3)	6 (2)	3 (3)	—	5 (5)	25 (4)	6 (2)	4 (1)	24/28	8
2 (1)	—	—	2	1 (1)	—	1 (1)	1 (1)	—	1	—	3 (1)	12/28	4
6 (3)	—	2 (1)	4 (1)	2 (1)	12 (3)	25 (21)	13 (8)	3 (3)	26 (5)	1	7 (2)	25/28	8
—	—	—	—		—	—	1 (1)	—	—	—	—	1/28	1
34 (15)	—	57 (23)	264 (40)	53 (28)	43 (11)	11 (9)	41 (28)	47 (43)	161 (29)	72 (26)	75 (17)	27/28	96
—	—	—	—	—	—	1 (1)	—	—	—	—	30 (7)	3/28	11
1	—	—	—	—	—	—	—	—	—	—	—	2/28	1
2 (1)	—	—	—	1 (1)	—	—	—	1 (1)	—	2 (1)	10 (2)	16/28	3
—	—	—	—	—	—	—		—	—	—	24 (6)	2/28	21
—	—	—	—	—	—	—		—	—	—		1/28	1
39 (18)	—	62 (25)	142 (22)	36 (19)	33 (8)	12 (10)	27 (18)	14 (13)	73 (13)	57 (21)	91 (21)	27/28	47
2 (1)	—	2 (1)	—	—	—	—	—	—	—	—	13 (3)	6/28	7
			—	—		—	1 (1)			22 (8)	32 (7)	12/28	12
10 (5)	2 (17)	7 (3)	20 (3)	10 (5)	24 (6)	5 (4)	—	7 (6)	16 (3)	6 (2)	13 (3)	26/28	10
222	12	245	657	188	395	120	148	109	553	277	434		

ON SOME PLANKTON ANIMALS COLLECTED BY THE SYUNKOTU-MARU IN MAY-JUNE 1954

II. SHELLS OF ATLANTIDAE (HETEROPODA)[1]

TAKASI TOKIOKA
Seto Marine Biological Laboratory, Sirahama

With Plates XV–XVI and 5 Text-figures

The following six species were found in the material:

Species	Individual number	Percentage
1. *Atlanta peroni*	21	27
2. *Atlanta gaudichaudi*	2	2
3. *Atlanta inclinata*	7	9
4. *Atlanta lesueuri*	37	47
5. *Atlanta inflata*	3	4
6. *Atlanta turriculata*	8	10
7. Damaged individual	1	1
	79	

All these species have been described repeatedly and already reported from the Indo-Pacific. However, to perfect our knowledge about the distribution of these pelagic shells I wish to record here the stations where these species occurred and to make my identification of these species credible I am going to give figures and data of measurements of each species in the following.

In descriptions of various species of this family, the relative breadth of the spire compared with the body-whorl is taken up as an important characteristic for the identification. However, I have scarcely been able to find the numerical representation of this character. Here, I offer the following method on trial:—

A...Long diameter of the shell, excluding the keel.

B...Diameter of the spire on the axis on which A is measured.

C...Diameter of the spire, excluding the penultimate-whorl, on the axis on which A and B are measured.

1) Contributions from the Seto Marine Biological Laboratory, No. 256.

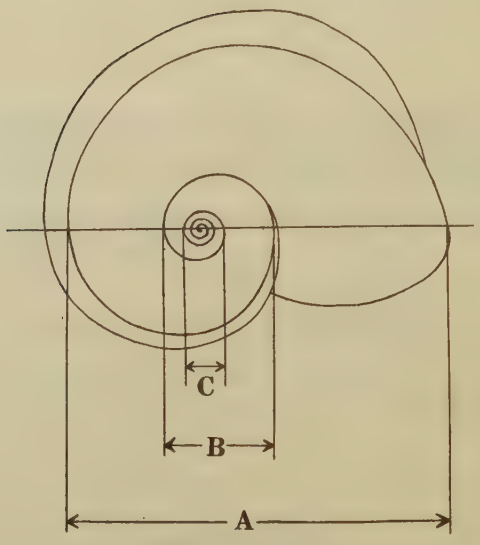


Fig. 1. Diagram showing the way of measurements for the whorl formula.

Whorl formula A:B:C is given as an indicator showing the rate of increase of whorl width. Theoretically, this rate may be given by coefficients in the involute formula, but it is practically impossible to calculate these coefficients in a short time on each specimen under consideration. Thus the above-mentioned whorl formula is tested here provisionally. All measurements were carried out on figures drawn by using camera lucida.

1. *Atlanta peroni* LESUEUR, 1817

(Pl. XV, Figs. A–D, F–H)

Atlanta peroni—SMITH (1888): p. 5.
VAYSSIÈRE (1904): p. 49, Pl. VI figs. 86–89.
TESCH (1906): p. 52, Pl. VII figs. 1, 7, 8.
TESCH (1908): p. 14, Pls. 1–2 figs. 7–9.
TESCH (1949): p. 16, Fig. 9.

Long diameter	Whorl formula	Number of whorls	Number of whorls on the under-side	Aperture width: height	Apical angle
0.9 mm	1 : 0.42 : 0.23	3¾			
1.7	1 : 0.36 : 0.17	4½		1 : 0.62	135°
2.2	1 : 0.38 : 0.15	4½	2¼		
2.6	1 : 0.33 : 0.13	4¾			
2.9	1 : 0.31 : 0.12	5½	2½	1 : 0.75	
3.0	1 : 0.34 : 0.12	5	2½	1 : 0.65	
3.0	1 : 0.31 : 0.12	4¾	3¾	1 : 0.73	148°
3.1	1 : 0.32 : 0.13	4½	3		
3.1	1 : 0.35 : 0.12	4½	3		
3.2	1 : 0.30 : 0.11	4¾			
3.3	1 : 0.25 : 0.09	4½	2¼		
3.3	1 : 0.30 : 0.11	5	2½	1 : 0.67	
5.0	1 : 0.31 : 0.10	5½	3		

The insertion degree of the keel is not always proportional to the body size. The keel is not yet inserted in shells smaller than 2.2 mm in long diameter, also even in a 3 mm individual. In a 3.3 mm individual the keel encircles five-eighths of the penultimate-whorl, while in a 5 mm individual it reaches merely to 1/4 of the penultimate-whorl. Spire low, usually purplish in colour; fine longitudinal striations are observable on some spire-whorls around the centre on both upper and under-sides. Minute umbilicus may be found in some rare cases. Shell generally translucent, slightly purplish in some specimens; although it may rarely be whitish and opaque. The base of the keel and some sutures are often coloured brownish. The middle part of the inner lip is brownish in some individuals.

Occurrence: St. 2 (9 individuals), St. 12 (1), St. 19 (3), St. 20 (4), St. 27 (1), St. 28 (3).

2. *Atlanta gaudichaudi* Souleyet, 1852

(Pl. XV, Fig. E; Text-fig. 2)

Atlanta gaudichaudi—Smith (1888): p. 5.
Tesch (1906): p. 54, Pl. VII figs. 11–13.
Tesch (1908): p. 16, Pls. 1–2 fig. 10.
Tesch (1949): p. 17, Fig. 10.

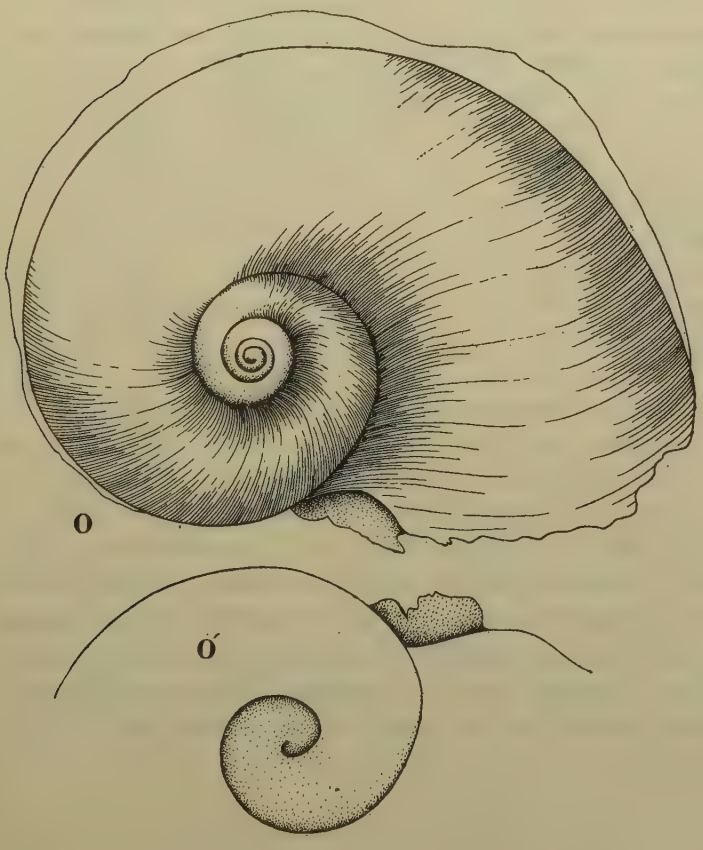


Fig. 2. *Atlanta gaudichaudi* Souleyet. O...Specimen with 2.7 mm long diameter, O'...Under-side of the spire of the same specimen, ×33.

Long diameter	Whorl formula	Number of whorls	Number of whorls on the under-side
2.0 mm	1 : 0.26 : 0.11	4½	
2.7	1 : 0.27 : 0.10	4½	2¾

Keel low and not inserted. Shell opaque and whitish; sutures brownish and spire coloured purple.

Occurrence: St. 19 (1), St. 20 (1).

3. *Atlanta inclinata* SOULEYET, 1852

(Pl. XVI)

Atlanta inclinata—SMITH (1888): p. 6.
TESCH (1908): p. 26.
TESCH (1949): p. 18, Fig. 12.
Atlanta gibbosa—TESCH (1906): p. 59, Pl. VIII fig. 27.
TESCH (1908): p. 27, Pl. 5 figs. 33 and 34.
Atlanta affinis—TESCH (1906): p. 53, Pl. VII figs. 9–10.
TESCH (1908): p. 16.

Long diameter	Whorl formula	Number of whorls	Number of whorls on the under-side	Aperture width: height	Apical angle
0.8 mm		4¼			
1.6	1 : 0.34 : 0.27	6			86°
1.9	1 : 0.30 : 0.21	6¼	2	1 : 0.64	100°
2.3	1 : 0.29 : 0.22	6	2		
2.5	1 : 0.29 : 0.18	5¾	2		
2.7	1 : 0.27 : 0.18	6	2¼	1 : 0.80	86°
4.0	1 : 0.29 : ·····	6¾	2¾		91°

The keel is not inserted in specimens smaller than 1.9 mm in long diameter. In a 4 mm individual it encircles three-fourths of the penultimate-whorl. Small and deep umbilicus may be observed on some of the specimens. Fine longitudinal striations are seen on a whorl or three-fourths of the whorl around the centre on the underside (Pl. XVI, Fig. M) in the 2.3 mm and the 2.5 mm individuals. This striated area is sharply edged with a line which is considered as representing the mark of the keel base. Shell translucent and faintly purplish to pale brownish, or whitish in colour. Spire yellowish brown or brownish. The inner lip purplish, with a brownish hue at the middle. Spire of a 1.6 mm individual is 0.73 mm in height; a fine transverse crest-like line may rarely be found on the spire.

Occurrence: St. 2 (1), St. 3 (1), St. 10 (2), St. 12 (2), St. 13 (1).

4. *Atlanta lesueuri* Souleyet, 1852

(Fig. 3)

Atlanta lesueuri—Smith (1888): p. 5.
Vayssière (1904): p. 48, Pl. V fig. 77.
Tesch (1908): p. 17, Pls. 1 & 2 figs. 11–12.
Tesch (1949): p. 17, Fig. 11.
Atlanta oligogyra—Tesch (1906): p. 54, Pl. VIII figs. 14–18.

Long diameter	Whorl formula	Number of whorls	Number of whorls on the under-side	Aperture width: height
0.6 mm	1 : 0.35 : 0.15	2½		
0.6				1 : 0.61
0.6	1 : 0.38 : 0.18	2¾		
0.7	1 : 0.25 : 0.13	2¾		
0.8				1 : 0.60
0.9	1 : 0.24 : 0.12	2¾		
0.9*	1 : 0.17 : 0.09	3¼	1¾	
1.0	1 : 0.21 : 0.10	2¾		
1.0	1 : 0.21 : 0.09	2¾	2	
1.0	1 : 0.26 : 0.11	3¼	1¾	
1.1	1 : 0.23 : 0.11	3¼		
1.3	1 : 0.20 : 0.10	3¼	1¾	
1.4	1 : 0.19 : 0.10	4	2¼	1 : 0.54
1.7	1 : 0.19 : 0.08	3¼	1¾	
1.8	1 : 0.17 : 0.09	3¼	1¾	
1.8	1 : 0.18 : 0.08	3¼	2	
1.8	1 : 0.17 : 0.09	3¾	2¾	1 : 0.64
1.9	1 : 0.20 : 0.08	3½		

* Measurements on the perfectly preserved part of the shell with ca. 1.5 mm long diameter.

Keel not inserted in specimens smaller than 1.4 mm in long diameter, even in a 1.8 mm individual. In 1.7–1.9 mm individuals it is inserted slightly. Spire very low, erected straightly or inclined very slightly; generally purplish in colour. Shell usually purplish, rarely whitish and translucent; keel colourless. Some specimens are provided with rather remarkable growth lines; inner lip purplish.

Occurrence: St. 2 (23), St. 3 (4), St. 14 (1), St. 21 (2), St. 22 (1), St. 24 (1), St. 27 (1), St. 28 (4).

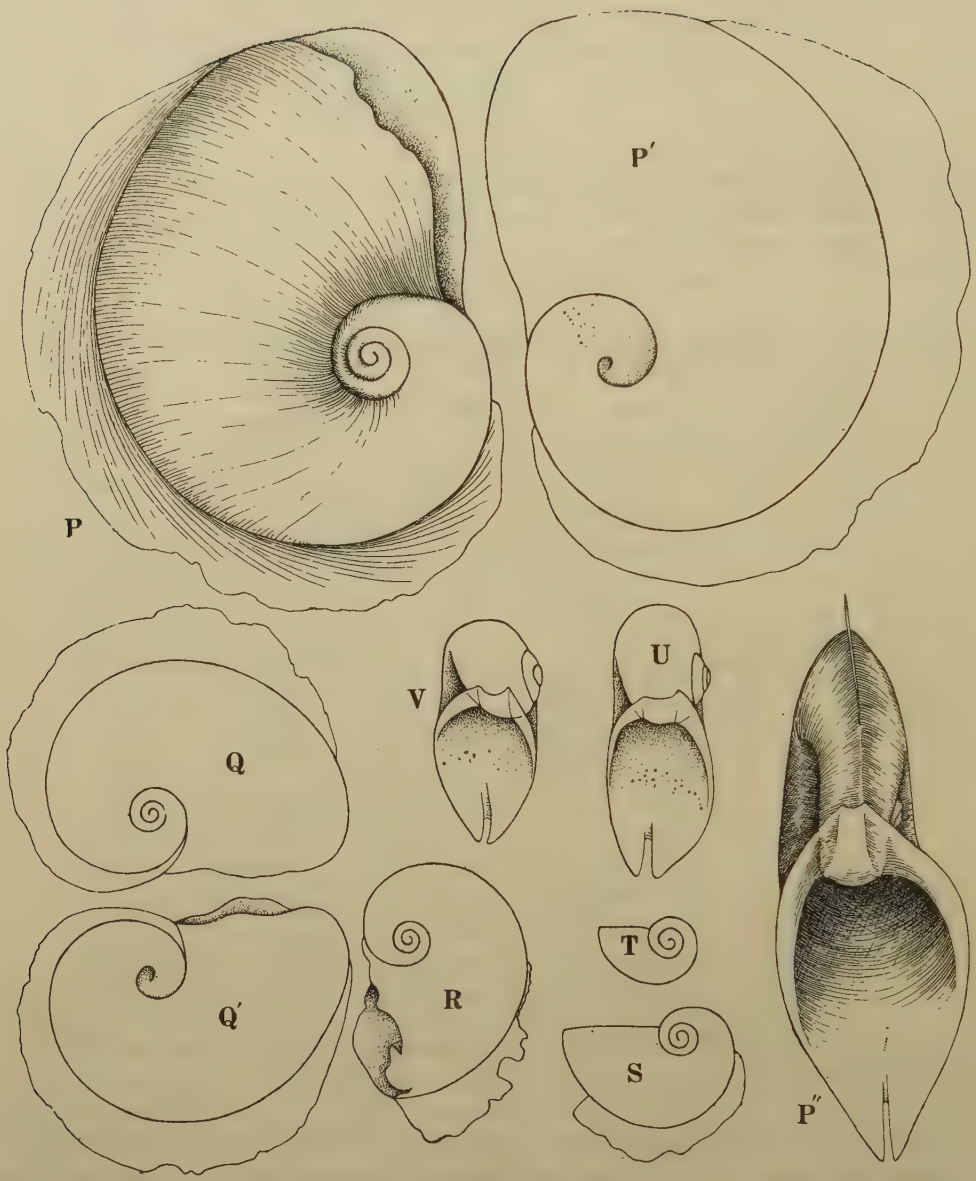


Fig. 3. *Atlanta lesueuri* SOULEYET.

P...Specimen with 1.4 mm long diameter, ×47. P′...Under-side of the same specimen, ×47, P″...Front of the same specimen, ×47. Q...Specimen with 1.7 mm long diameter, ×23. Q′... Under-side of the same specimen, ×23. R...Specimen with 1.3 mm long diameter, ×23. S... Specimen with 0.9 mm long diameter, ×23. T...Specimen with 0.6 mm long diameter, ×23. U...Specimen with 0.8 mm long diameter, front, ×47. V...Specimen with 0.6 mm long diameter, front, ×47.

5. *Atlanta inflata* Souleyet, 1852

(Fig. 4)

Atlanta inflata—Smith (1888) : p. 5.
Tesch (1906) : p. 55, Pl. VIII figs. 19–21.
Tesch (1908) : p. 19, Pls. 3 & 4 figs. 13–17.
Tesch (1949) : p. 19, Fig. 13.

Long diameter	Whorl formula	Number of whorls	Number of whorls on the under-side	Aperture width : height	Apical angle
0.58mm	1 : 0.55 : 0.39	4¼		1 : 1.6	113
1.4	1 : 0.30 : 0.14	5			
1.6	1 : 0.31 : 0.17	5¼	2	1 : 0.75	126

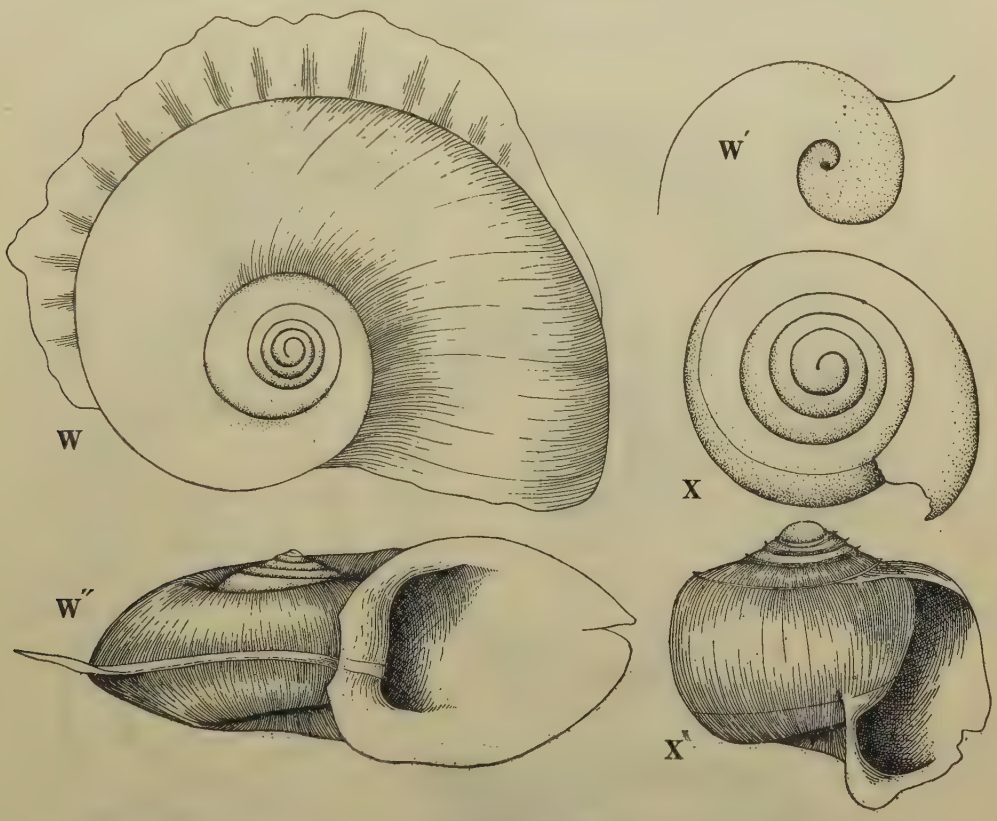


Fig. 4. *Atlanta inflata* Souleyet.
W...Specimen with 1.6 mm long diamater, ×47. W′...Under-side of the spire of the same specimen, ×47. W″...Front of the same specimen, ×47. X...Specimen with 0.58 mm long diameter, ×73. X′...Front of the same specimen, ×73.

Keel not inserted, quite absent in the 0.58 mm individual. Slightly undulating appearance of the keel of the 1.6 mm individual is probably an unnatural feature.

Umbilicus distinct, small but deep. Spire may be slightly inclined in some specimens, it is generally dark violet in colour; protoconch rather large. On the 0.58 mm individual, two transverse ridges are found on the body-whorl one at each of the levels of upper and lower edges of the inner lip, the upper one of which is more remarkable than the lower. The penultimate-whorl has a peripheral ridge and the vepionic-whorl has a peripheral ridge and an inner marginal one. Shell usually reddish purple in colour, the clearness of the growth lines differs considerably according to the state of the preservation of specimens.

Occurrence: St. 2 (3).

6. *Atlanta turriculata* D'ORBIGNY, 1836

(Fig. 5)

Atlanta turriculata—TESCH (1906): p. 58, Pl. VIII fig. 25.
TESCH (1908): p. 24, Pls. 3 & 4 figs. 25 and 26.
TESCH (1949): p. 20, Fig. 16.

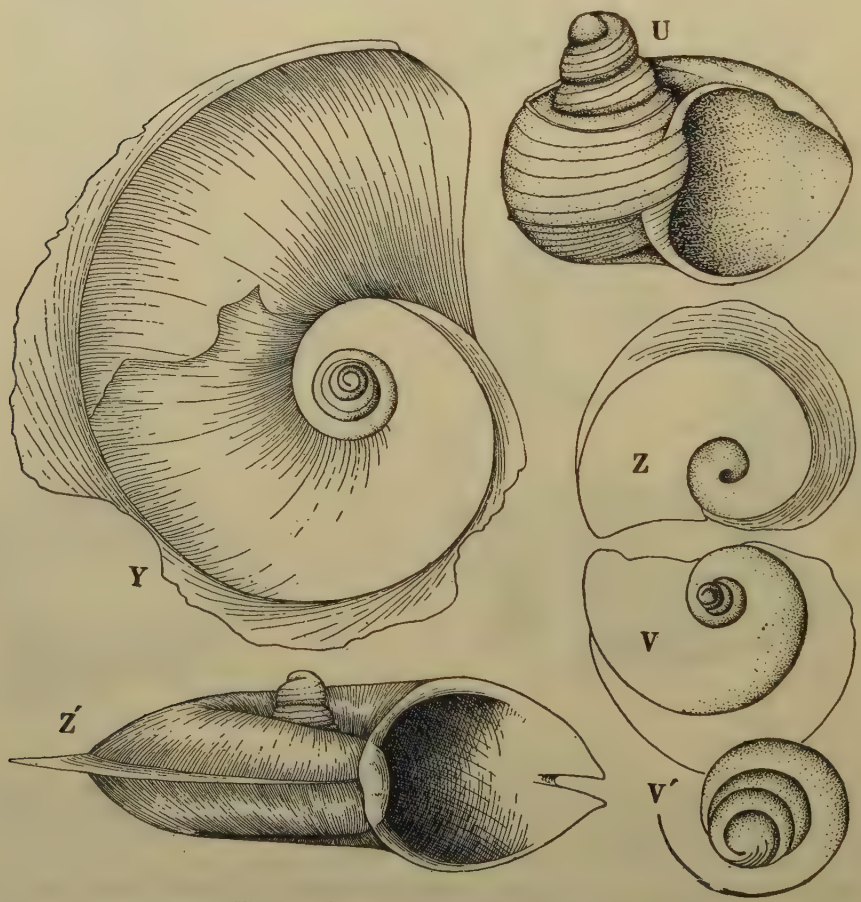


Fig. 5. *Atlanta turriculata* D'ORBIGNY.
Y...Specimen with 1.6 mm long diameter, ×47. Z...Specimen with 1.3 mm long diameter, ×23. Z'...Front of the same specimen, ×47. U...Specimen with 0.6 mm long diameter, ×73. V...Specimen with 1.3 mm long diameter, ×23. V'...Spire of the same specimen, ×73.

Long diameter	Whorl formula	Number of whorls	Number of whorls on the under-side	Aperture width : height
0.6 mm		4		1 : 1.0
1.3	1 : 0.26 : 0.14	4½	2	1 : 0.78
1.3	1 : 0.26 : 0.11	4¾	1¾	
1.6	1 : 0.26 : 0.13	5½	2¼	

Keel tall, inserted considerably in the 1.6 mm specimen, but only slightly or not inserted in 1.3 mm individuals. Spire tall and narrow, erected straightly or slightly inclined; it is dark violet to purplish brown in colour, very rarely even whitish. The under-side of the spire is also purplish brown. Fine slightly undulating transverse striations on 2-3 distal whorls of the spire, although this striations may rarely be very insignificant. The 0.6 mm individual has seven striations on the surface of the body-whorl upper than the level of the lower edge of the inner lip, of which the first and the last ones are more remarkable than others; besides 6–8 much finer striations on the under-side of the body-whorl, 4 on the vepionic-whorl and 3 on the penultimate-whorl. Shell usually lilac in colour, inner lip purplish.

Occurrence: St. 2 (5), St. 3 (1), St. 27 (1), St. 28 (1).

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EXPLANATION OF PLATES XV–XVI

Plate XV

Figs. A–D, F–H. *Atlanta peroni* Lesueur.

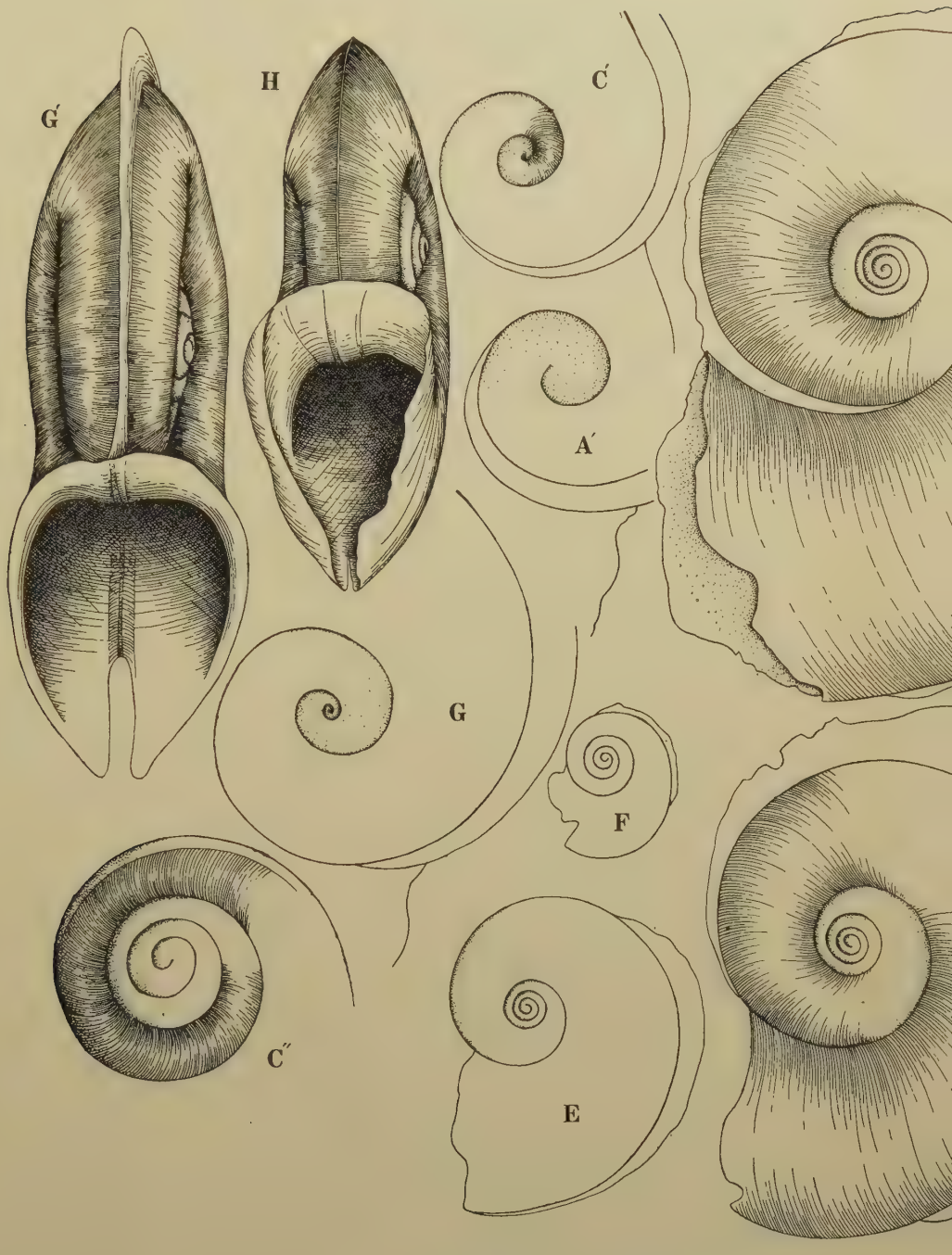
A ...Specimen with 3.3 mm long diameter, ×23.
A′ ...Under-side of the spire of the same specimen, ×23.
B ...Specimen with 2.9 mm long diameter, ×33.
C ...Specimen with 5.0 mm long diameter, ×15.
C′ ...Under-side of the spire of the same specimen, ×15.
C″...Spire of the same specimen, ×73.
D ...Specimen with 3.0 mm long diameter, ×23.
F ...Specimen with 0.9 mm long diameter, ×23.
G ...Specimen with 3.0 mm long diameter, under-side, ×33.
G′ ...Front of the same specimen, ×33.
H ...Front of the specimen with 1.7 mm long diameter, ×47.

Fig. E. *Atlanta gaudichaudi* Souleyet...Specimen with 2.0 mm long diameter, ×23.

Plate XVI

Figs. I–N′. *Atlanta inclinata* Souleyet.

I ...Specimen with 4.0 mm long diameter, ×23.
J ...Specimen with 1.9 mm long diameter, ×47.
J′ ...Front of the same specimen, ×47.
K ...Specimen with 1.6 mm long diameter, ×47.
L ...Front of the specimen with 2.7 mm long diameter, ×33.
M ...Under-side of the spire of the specimen with 2.3 mm long diameter, ×33.
N ...Specimen with 0.8 mm long diameter, ×47.
N′ ...Under-side of the spire of the same specimen, ×47.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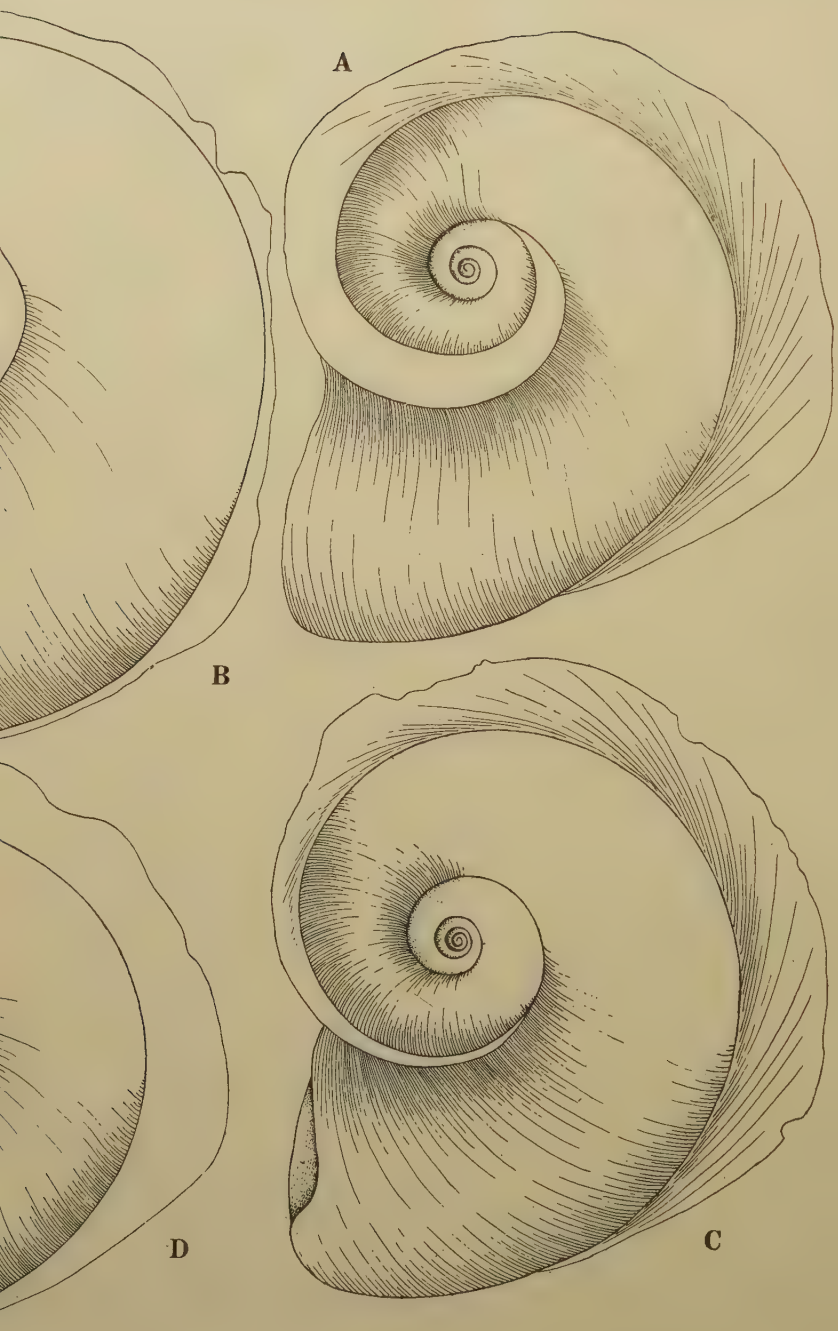

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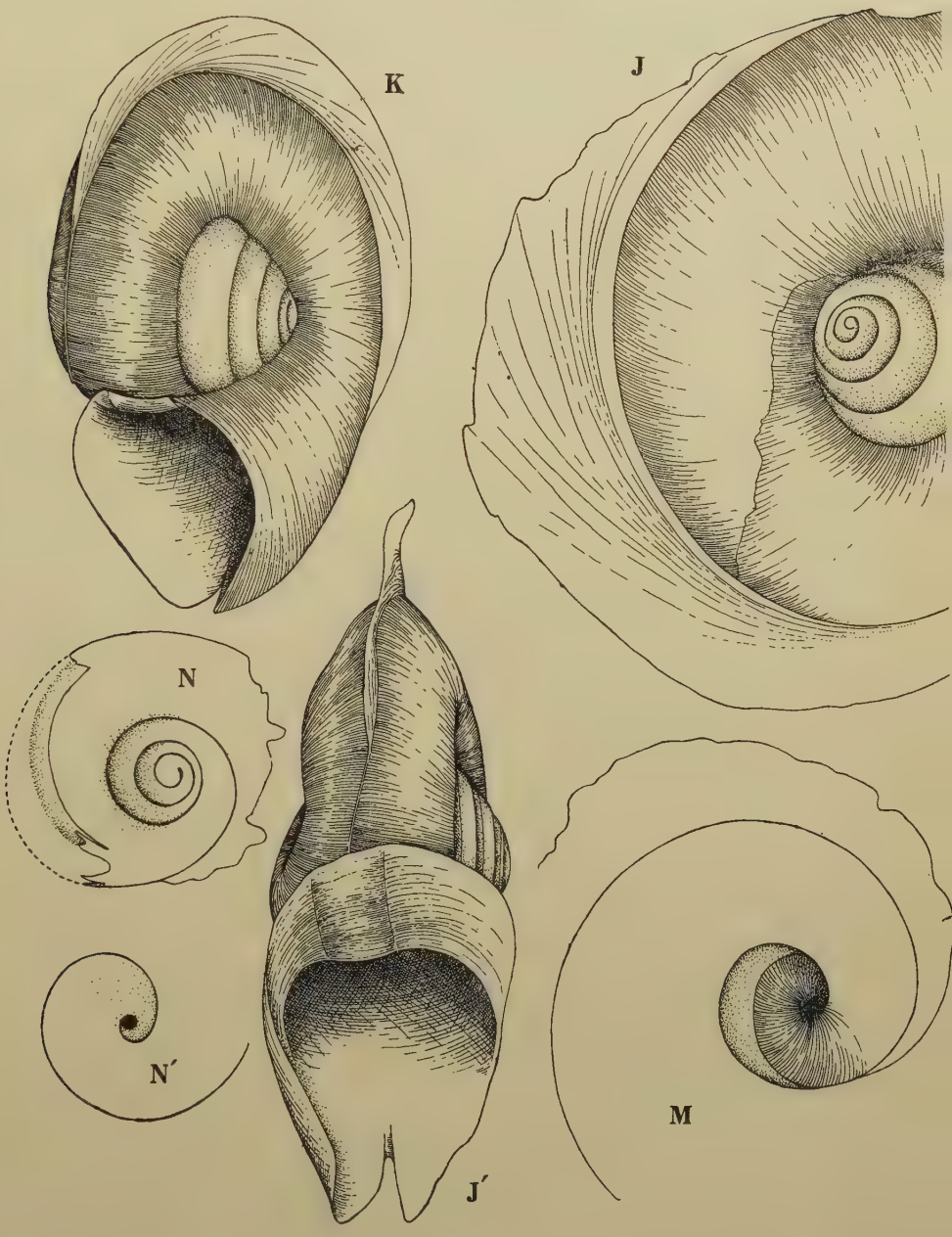
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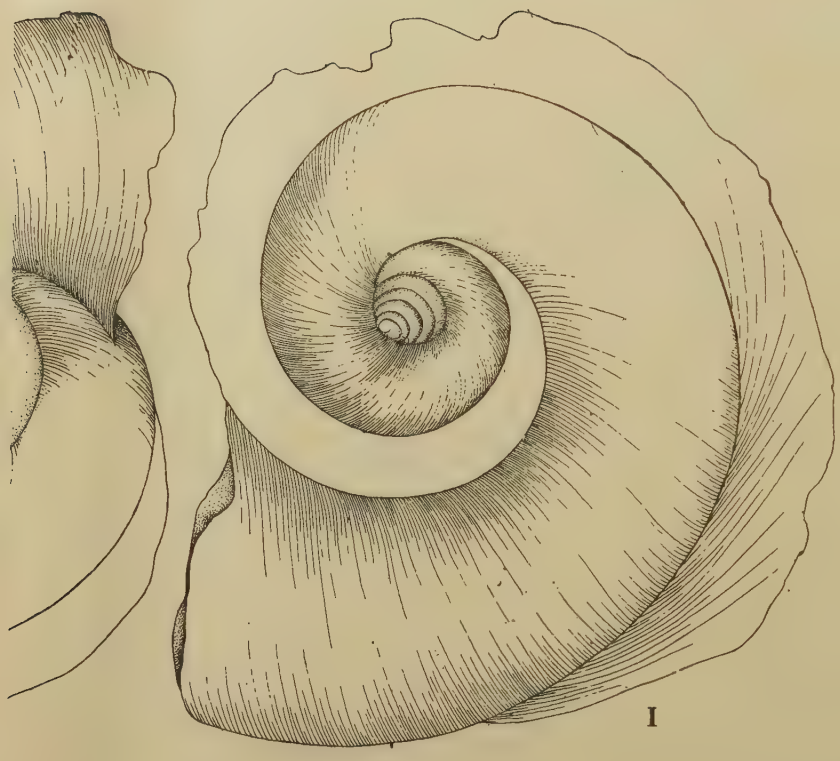

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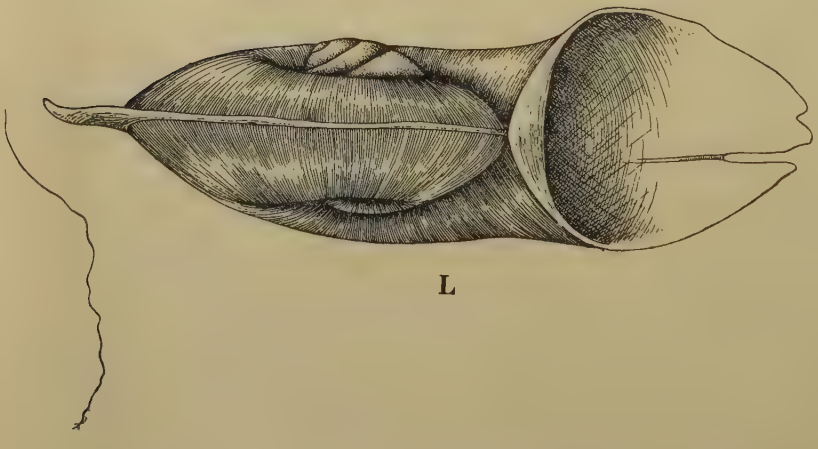

L

SHELLS OF ATLANTIDAE (HETEROPODA) COLLECTED BY THE SÔYÔ-MARU IN THE SOUTHERN WATERS OF JAPAN[1)]

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With Plates XVII–XVIII and 10 Text-figures

Far ago, I had an opportunity of examining a number of plankton samples collected by the Sôyô-Maru chiefly in the southern waters of Japan including Bays of Sagami and Suruga and a part of the eastern waters in the years 1934 and 1937–1939. I selected at that time shells of Atlantidae out of the material and prepared abundant figures and data about their occurrence. Here, these figures and data are arranged for publication.

At first, the following six species are easily discriminated:

Oxygyrus keraudreni
Atlanta peroni
Atlanta inclinata
Atlanta lesueuri
Atlanta fusca
Atlanta turriculata

1. *Oxygyrus keraudreni* (LESUEUR), 1817

(Figs. 1–2)

Oxygyrus keraudreni—SMITH (1888): p. 6.
VAYSSIÈRE (1904): p. 56, Pl. V figs. 71–75.
TESCH (1949): p. 10; Figs. 1–3, 44.
Oxygyrus keraudreni+*Oxygyrus rangi*—TESCH (1908): pp. 5 and 6.
Oxygyrus rangi—TESCH (1906): p. 49; Pl. VII figs. 2-4, 6B.

Long diameter	Whorl formula	Number of whorls	Aperture width: height	Height of keel
1.5 mm				640 μ
1.5	1 : 0.25 : —	2	1 : 1.3	690
1.7	1 : 0.24 : —	2	1 : 1.3	740

1) Contributions from the Seto Marine Biological Laboratory, No. 257.

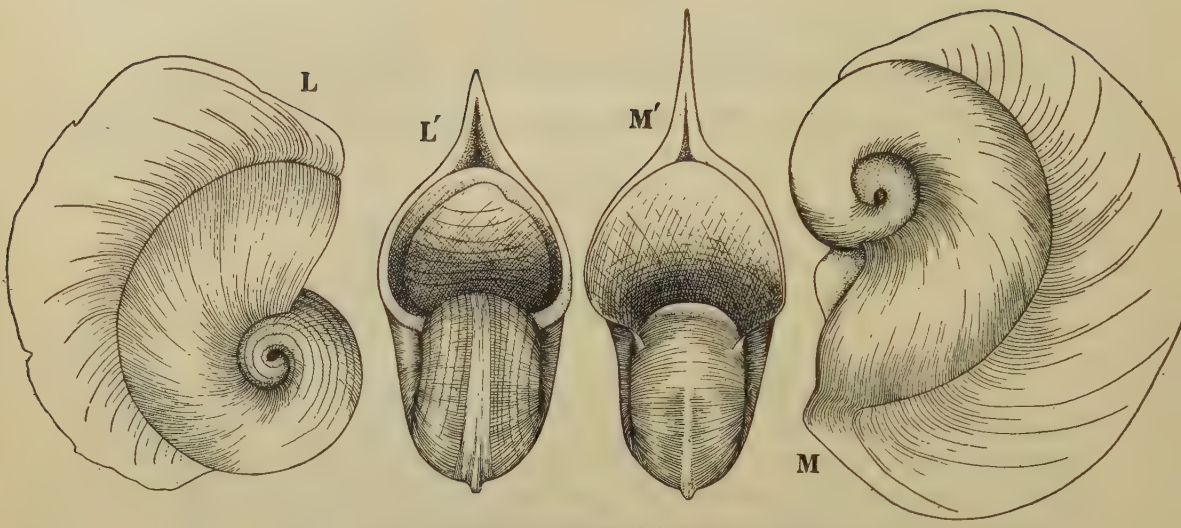

Fig. 1. *Oxygyrus keraudreni* (LESUEUR). ×28.
L—Specimen with 1.5 mm long diameter, with striations. L′—Front of the same specimen. M—Specimen with 1.7 mm long diameter, without striations. M′—Front of the same specimen.

1.5 mm individuals (Fig. 1 L and Fig. 2) are provided with distinct transverse undulating striations on the penultimate-whorl and the first 1/4 of the body-whorl, while the 1.7 mm individual is devoid of this sculpture. Umbilicus small but very distinct. A 1.5 mm individual carries two spermatophores on one side of the shell, they are respectively 640 μ and 710 μ in length, ca. 210 μ in width and yellowish in colour.

Occurrence: 1938—St. 5 (2 individuals), St. 98 (2), St. 103 (2); 1939—St. 10 (1).

Fig. 2. *Oxygyrus keraudreni* (LESUEUR). ×28. Specimen with 1.5 mm long diameter, with two spermatophores.

2. *Atlanta peroni* LESUEUR, 1817

(Fig. 3)

Long diameter	Whorl formula	Number of whorls	Number of whorls on the under-side	Aperture width : height
1.3 mm	1 : 0.34 : 0.19	4¾		
3.2	1 : 0.31 : 0.11	5	3	1 : 0.61

The keel is not inserted in the 1.3 mm individual, but it encircles 1/4 of the penultimate-whorl in the 3.2 mm individual. Minute umbilicus observed in the 3.2 mm individual. Shell translucent may be whitish in some small-medium sized individuals; the base of the keel brownish in some specimens. The middle part of the inner lip brownish in the 3.2 mm specimen. The spire of the 1.3 mm individual is reddish brown in colour and striped with purplish longitudinal colour bands as shown in Fig. 3.

Occurrence: 1938—St. 95 (2); 1939—St. 21 (2), St. 84 (4).

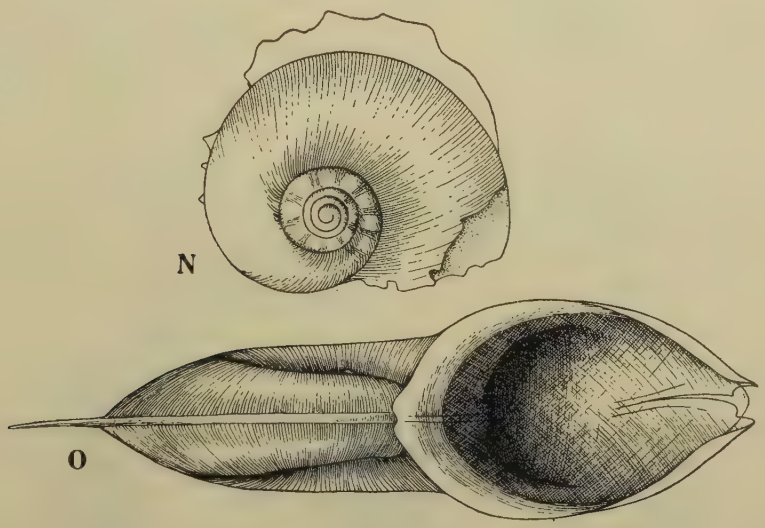

Fig. 3. *Atlanta peroni* LESUEUR. N—Specimen with 1.3 mm long diameter, ×30. O—Front of the specimen with 3.2 mm long diameter, ×28.

3. *Atlanta inclinata* SOULEYET, 1852

Long diameter	Whorl formula	Number of whorls	Aperture width: height	Apical angle
1.8 mm	1 : 0.32 : —	6	1 : 0.73	86°
2.1	1 : 0.32 : 0.24	6½	1 : 0.77	
5.0				

The keel is not yet inserted in the 2.1 mm individual, while it encircles nearly 1/4 of the penultimate-whorl in the 1.8 mm individual. It is rather high in the 1.8 mm individual, about 380 μ in height. Spire strongly inclined and yellowish brown in colour. The middle part of the inner lip and the inner side of the body-whorl near the aperture are purplish in colour.

Occurrence: 1934—St. 11 (2), 1937—St. 78 (1), 1939—St. 21 (15),

4. *Atlanta lesueuri* SOULEYET, 1852

(Fig. 4)

Long diameter	Whorl formula	Number of whorls	Number of whorls on the under-side	Aperture width : height
1.4 mm	1 : 0.19 : 0.10	3¼		
1.9	1 : 0.22 : 0.09	3½	2¼	1 : 0.66
2.1	1 : 0.17 : 0.09	3¼	2	1 : 0.63
2.2	1 : 0.16 : 0.07	3¼	2	1 : 0.62
2.4	1 : 0.17 : 0.08	3¼	2	1 : 0.61
2.7	1 : 0.18 : 0.07	3¼	2	1 : 0.72

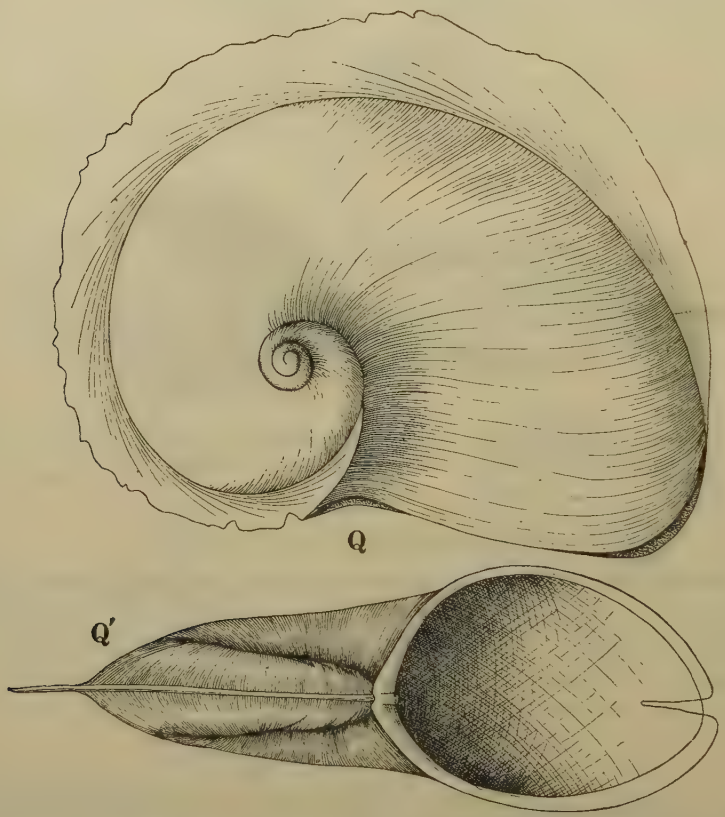

Fig. 4. *Atlanta lesueuri* SOULEYET. ×30. Q—Specimen with 2.7 mm long diameter. Q′—Front of the same specimen.

The keel is slightly inserted in 1.9–2.2 mm specimens and encircles nearly 1/4 of the penultimate-whorl in the 2.7 mm individual, but it is not inserted in the 2.4 mm individual. The spire may rarely be inclined very slightly; it is low and usually

scarcely visible in the front view, although 1-2 tip-whorls can be seen in some specimens. The middle part of the inner lip is usually coloured violet.

Occurrence: 1934—Sagami Bay (1); St. F2 (1), St. 6′ (251); 1938—St. 5 (1), St. 9 (33), St. 77 (4), St. 95 (11), St. 98 (88), St. 103 (29); 1939—St. 5 (3), St. 21 (8), St. 25 (1), St. 26 (1), St. 35 (1), St. 40 (1), St. 75 (1), St. 92 (1), St. 125 (3).

5. *Atlanta fusca* Souleyet, 1852

(Pl. XVIII, Figs. J-K)

Atlanta fusca—Smith (1888): p. 6.
Tesch (1906): p. 60, Pl. VIII figs. 28-30.
Tesch (1908): p. 25, Pls. 3 & 4 figs. 27-29.
Tesch (1949): p. 20, Fig. 15.
Atlanta inclinata (part)—Vayssière (1904): p. 53, Pl. VI fig. 91.

Long diameter	Whorl formula	Number of whorls	Number of whorls on the under-side	Aperture width: height	Apical angle
1.5 mm	1 : 0.31 : 0.18	4¼		1 : 0.95	72°
2.5	1 : 0.28 : 0.14	4¾	2	1 : 0.86	63°

The keel not inserted in the 1.5 mm individual, while it encircles nearly 1/4 of the penultimate-whorl in the 2.5 mm individual; it ends very near the aperture. It is very tall, about 390 μ even in the smaller specimen; the basal portion is opaque and whitish, while the marginal portion is transparent. Spire erected straightly or inclined slightly. Fine undulating transverse striations on the under-side and the lower half of the upper side of the penultimate-whorl in the larger individual, while these striations are found also on the initial 1/4 of the body-whorl in the smaller one. Shell bistre to pale brownish in colour, with brownish longitudinal stripes in the larger specimen. A darkly pigmented pattern beneath the operculum; generally it consists of two oval figures arranged side by side.

Occurrence: 1934—St. 13 (1), 1938—St. 9 (1), 1939—St. 21 (1).

6. *Atlanta turriculata* d'Orbigny, 1836

(Fig. 5)

Long diameter	Whorl formula	Number of whorls	Number of whorls on the under-side	Aperture width: height	Apical angle
1.4 mm	1 : 0.26 : 0.16	4¾	2	1 : 0.84	42°
1.6	1 : 0.25 : 0.12	4¾	2	1 : 0.84	25°
2.2	1 : 0.27 : 0.12	5¼	2¼	1 : 0.85	38°

The keel not inserted in two smaller specimens, while it encircles ca. 1/8 of the penultimate-whorl in the largest one. It is tall, ca. 380 μ in the 1.6 mm individual; its wide basal portion is opaque and whitish, while the marginal portion is always transparent. The spire tall and narrow and may be slightly inclined in some specimens, it is purplish or reddish brown in colour. The 1.4 mm and the 1.6 mm

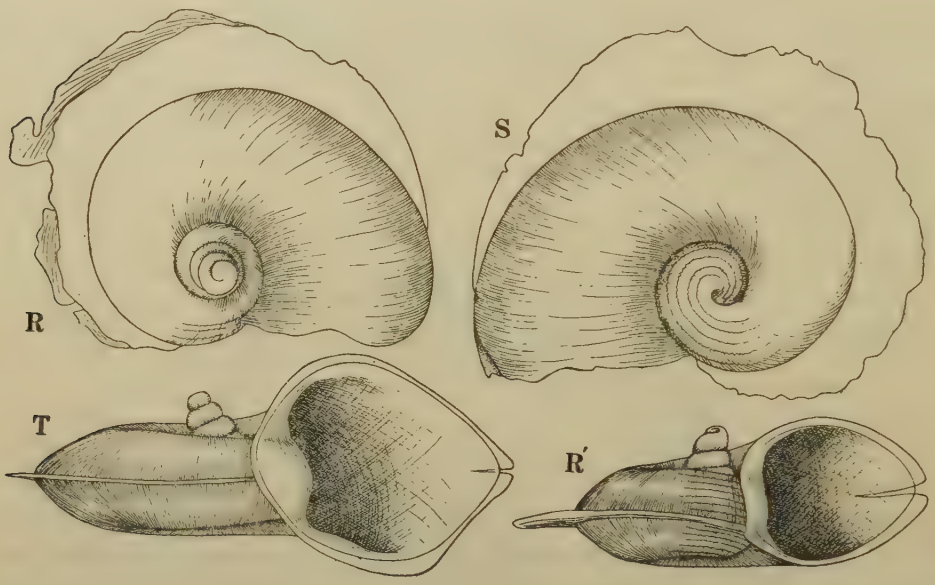

Fig. 5. *Atlanta turriculata* d'Orbigny. ×30.
R—Specimen with 1.4 mm long diameter. R'—Front of the same specimen. S—Specimen with 1.6 mm long diameter. T—Front of the specimen with 2.2 mm long diameter.

individuals are provided with fine transverse undulating striations arranged just as in the preceding species, while the largest specimen is quite devoid of these sculptures. The middle part of the inner lip purplish in colour. The shell along the base of the keel is brownish in the 1.6 mm individual.

Occurrence: 1938—St. 84 (1), St. 95 (1), St. 103 (1); 1939—St. 5 (1), St. 18 (1).

Twenty-five representatives, remained undetermined, were measured carefully on figures drawn by using camera lucida. Then they were plotted on the graph each according to values B/A and C/A. Specific analysis was attempted on situations of these representatives, taking the number of whorls into consideration.

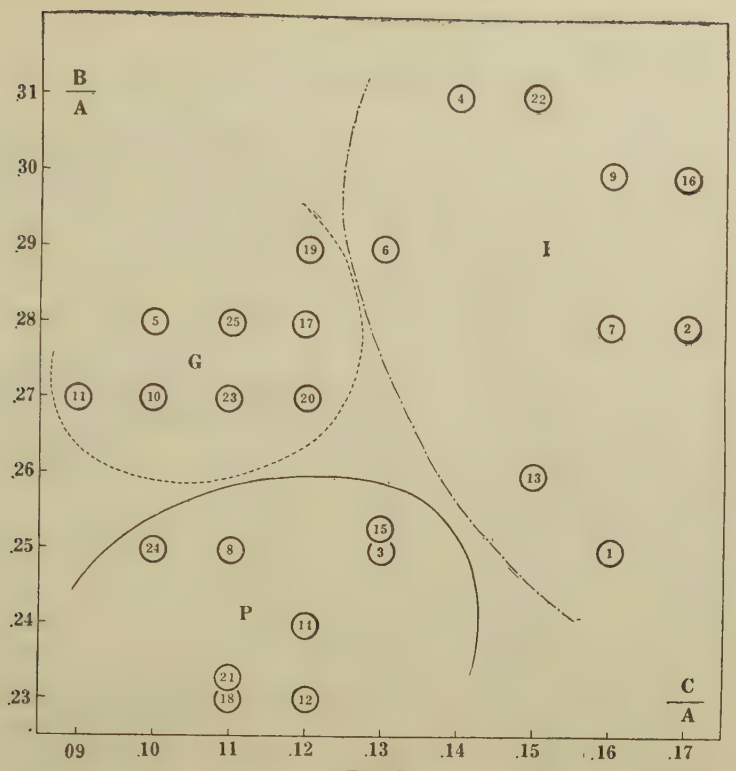

Fig. 6

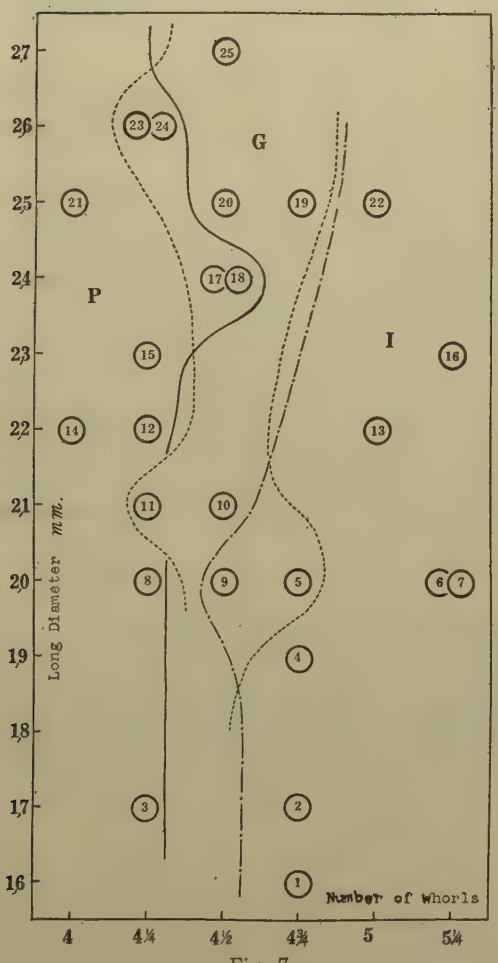

Fig. 6. Graph showing situations of 25 undetermined specimens according to values of B/A and C/A. Specimen number is indicated in the circle.

Fig. 7. Graph showing situations of 25 undetermined specimens according to body size and number of whorls. Specimen number is indicated in the circle.

Specimen number	Long diameter	Whorl formula	Number of whorls	Number of whorls on the under-side	Keel
1	1.6mm	1 : 0.25 : 0.16	4¾	2	not inserted.
2	1.7	1 : 0.28 : 0.17	4¾	2	"
3	1.7	1 : 0.25 : 0.13	4¼	2	"
4	1.9	1 : 0.31 : 0.14	4¾	3	"
5	2.0	1 : 0.28 : 0.10	4¾	2½	inserted very slightly.
6	2.0	1 : 0.29 : 0.13	5¼	2¾	encircles ¼ of the penultimate-whorl.
7	2.0	1 : 0.28 : 0.16	5¼	2¼	not inserted.
8	2.0	1 : 0.25 : 0.11	4¼	2¼	"
9	2.0	1 : 0.30 : 0.16	4½	2¼	"
10	2.1	1 : 0.27 : 0.10	4½	2½	"
11	2.1	1 : 0.27 : 0.09	4¼	2½	"
12	2.2	1 : 0.23 : 0.12	4¼	2	"
13	2.2	1 : 0.26 : 0.15	5	2¼	"
14	2.2	1 : 0.24 : 0.12	4	2	"
15	2.3	1 : 0.25 : 0.13	4¼	2	encircles ¼ of the penultimate-whorl.
16	2.3	1 : 0.30 : 0.17	5¼	2¼	not inserted.
17	2.4	1 : 0.28 : 0.12	4½	3¼	inserted very slightly.
18	2.4	1 : 0.23 : 0.11	4½	2	not inserted.
19	2.5	1 : 0.29 : 0.12	4¾	2¼	"
20	2.5	1 : 0.27 : 0.12	4½	2¾	"
21	2.5	1 : 0.23 : 0.11	4	2	encircles ⅛ of the penultimate-whorl.
22	2.5	1 : 0.31 : 0.15	5	2¼	not inserted.
23	2.6	1 : 0.27 : 0.11	4¼	2¼	"
24	2.6	1 : 0.25 : 0.10	4¼	2½	inserted very slightly.
25	2.7	1 : 0.28 : 0.11	4½		not inserted.

At Figures 6 and 7, three groups may be readily distinguishable from one another, of which Group G consists of specimens Nos. 5, 10, 11, 17, 19, 20, 23 and 25, Group P includes specimens Nos. 3, 8, 12, 14, 15, 18, 21 and 24 and Group I is constituted with specimens Nos. 1, 2, 4, 6, 7, 9, 13, 16 and 22. The Group I is characterized by high values of B/A and C/A and the large number of whorls, the Group G by relatively high value of B/A and low C/A and the Group P by low values of both B/A and C/A. The measurements on figures of type specimens or typical specimens of several species drawn by TESCH by using camera lucida show the following numerical characteristics :—

Atlanta gaudichaudi

Long diameter	Whorl formula	Number of whorls	Source
2.8 mm	1 : 0.31 : 0.11	4¼	1906
2.8	1 : 0.28 : 0.10	4¾	1908
3.0	1 : 0.29 : 0.09	4½	1949

Atlanta inflata			
1.4	1 : 0.33 : 0.22	4½	1906
1.5	1 : 0.28 : 0.15	5½	1908
1.7	1 : 0.33 : 0.16	4¾	1949
1.8	1 : 0.30 : 0.16	6	1908
(*Atlanta depressa*)			
1.7	1 : 0.32 : 0.18	5	1908
(*Atlanta rosea*)			
1.5	1 : 0.28 : 0.17	5	1906
Atlanta helicinoides			
1.5	1 : 0.37 : 0.22	4½	1908
1.8	1 : 0.35 : 0.19	6	1949

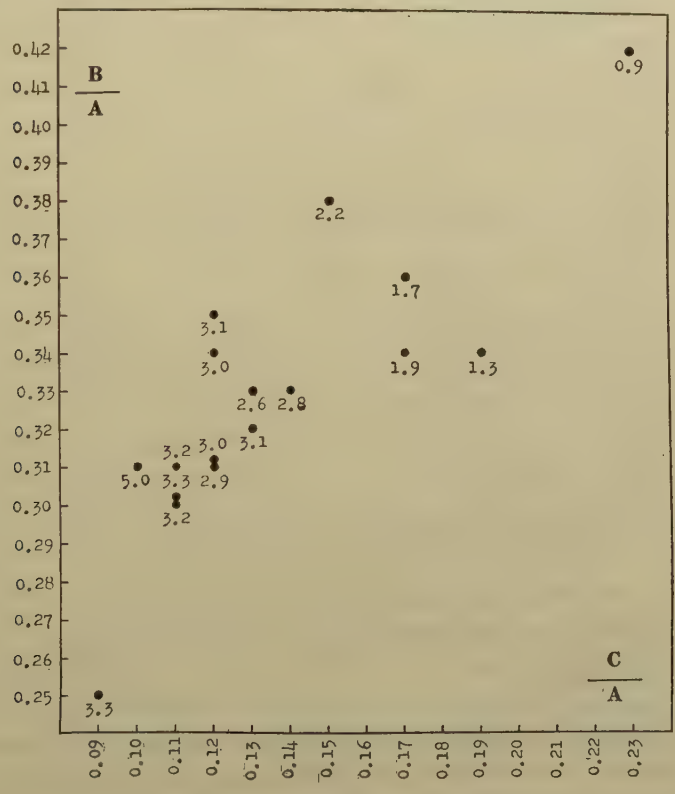

Fig. 8. *Atlanta peroni* LESUEUR.
Graph showing the relation between the body size and values of B/A and C/A. Numerals indicate long diameters of specimens in mm.

Comparing the numerical data of three groups carefully with the table given above, it is easily understood that the Group I represents *Atlanta inflata* and the Group G *Atlanta gaudichaudi*. Here, the Group P remains undetermined.

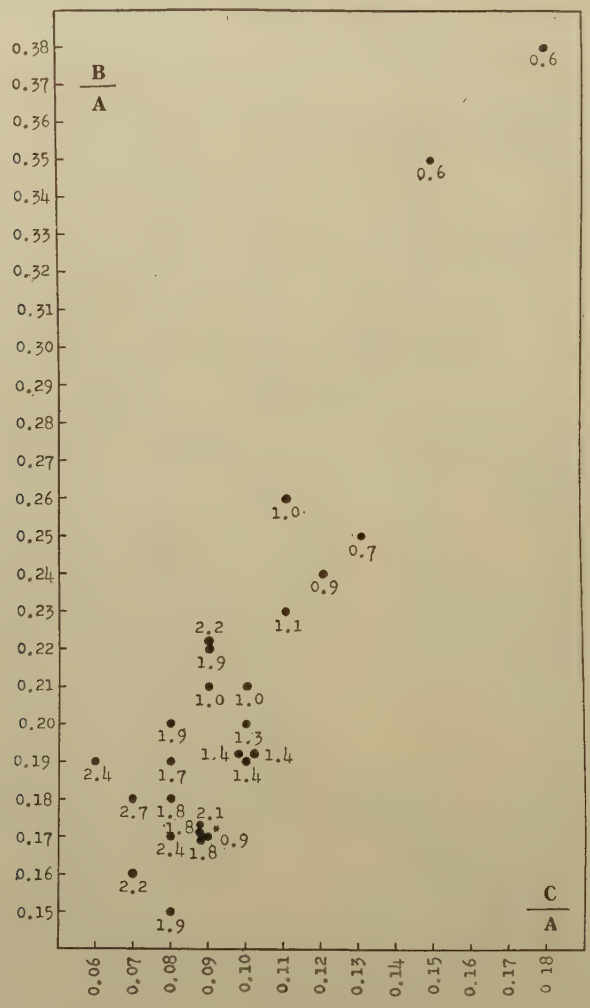

Fig. 9. *Atlanta lesueuri* SOULEYET.
Graph showing the relation between the body size and values of B/A and C/A. Numerals indicate long diameters of specimens in mm.

Generally speaking, the number of whorls increases with the size of the shell. Thus, it is impossible that the Group P represents the older stages of *At. inflata*, because in spite of the fact that many specimens in the Group P are much larger than some of *At. inflata*, they are provided with less whorls. Then arises the question whether the Group P represents a phase of the variation in *Atlanta gaudichaudi* or

not. To offer a ground on which the present question may be discussed, the numerical data of *At. peroni* and *At. lesueuri*, both commonly and numerously occurring species in the western Pacific, are figured in graphs showing the relation between the body size and values B/A and C/A. At Figures 8 and 9, it is conceivable that values B/A and C/A become smaller according to the growth of the shell. The distribution of specimens of the Groups P and G in Fig. 6 does not seem to be arranged in the order of the body size, but rather it seems quite irregular. Thus, the Group P can not be considered as the group embracing older stages of *At. gaudichaudi* in spite of the lower value of B/A in the Group P. Number of whorls in the Group P slightly fewer than in *At. gaudichaudi* seems to guarantee the present consideration. There are two possible ideas about the Group P, one is that the Group P represents a new species and the other means the existence of the range of variation in values B/A and C/A and the number of whorls in *At. gaudichaudi* much wider than hitherto to be considered. At present, I propose to treat the Group P as a new species for convenience' sake of recording and to name it *Atlanta pacifica.*

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7. *Atlanta gaudichaudi* Souleyet, 1852

(Pl. XVIII, Figs. H–I; Text-fig. 10)

Nine specimens (2.0–2.7 mm in long diameter) were measured; B/A is 0.27–0.29 (0.28 on average) and C/A is 0.09–0.13 (0.11 on average); number of whorls 4¼–5¼ (ca. 4½ on average) and number of whorls on the under-side is 2¼–3¼ (mean number ca. 2½), and the height/width of the aperture is 0.52–0.66 (0.59 on average). The keel is usually not inserted, although it is slightly inserted or encircles ca. 1/4 of the penultimate-whorl in three of the examined specimens. It may be rather tall in some specimens, for instance 470 μ in height in a 2.7 mm specimen (not inserted); the basal part is generally thickened considerably. Spire purplish in colour and low, merely the tip or the neighbourhood of the tip is visible in the front view of the shell; in some individuals it is quite concealed by the body-whorl. Shell translucent and faintly purplish, may be whitish in rare cases. Brownish tint along the keel base and the suture in some specimens. Small but deep umbilicus may be found in some specimens.

Occurrence: 1934—Sagami Bay (1); 1938—St. 2 (1), St. 9 (8), St. 13 (93), St. 98 (2); 1939—St. 70 (2).

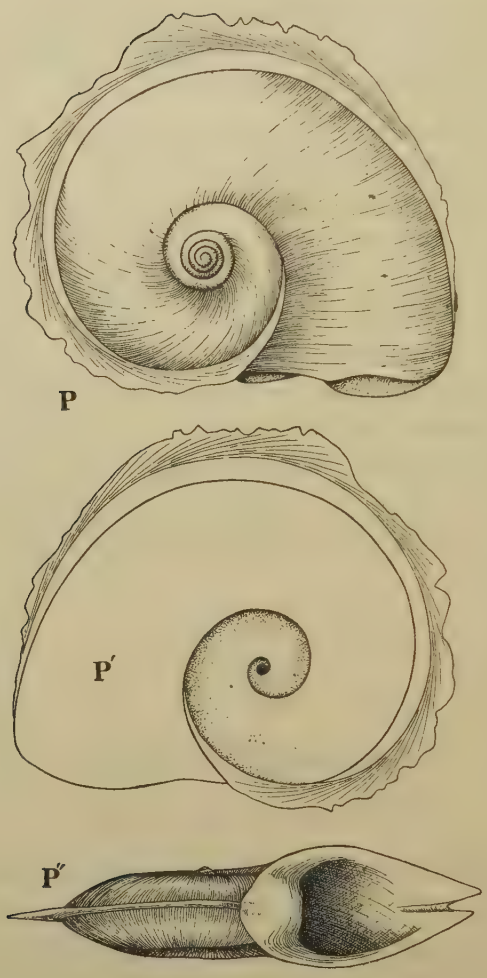


Fig. 10. *Atlanta gaudichaudi* SOULEYET with inserted keel, ×28. P -Specimen with 2.0 mm long diameter. P′ -Under-side of the same specimen. P″—Front of the same specimen.

8. *Atlanta inflata* SOULEYET, 1852

(Pl. XVII, Figs. A–C)

Eight specimens (1.6–2.5 mm in long diameter) were measured; B/A is 0.25–0.31 (0.29 on average) and C/A is 0.14–0.17 (0.16 on average); number of whorls 4½–5¼ (mean number ca. 5) and number of whorls on the under-side is 2–3 (mean number ca. 2¼), and the height/width of the aperture is 0.60–0.89 (0.74 on average). The keel is never inserted; it is tall in some specimens, for instance 580 μ in the 2.3 mm specimen. The basal part of the keel is opaque and whitish in colour, while

the marginal part is translucent. Spire purplish or purplish brown in colour and tall and wide, with the apical angle 84°–125°, 107° on average. It is erected straightly or inclined slightly, and protruded prominently from the level of the upper edge of the body-whorl and easily observable in the front view. Faint and fine transverse striations on the under-side of the spire of the 1.6 mm individual. Shell whitish or purplish in colour, the neighbourhood of the aperture is translucent; the keel base and sutures are brownish in some specimens. The middle part of the inner lip is purplish.

Occurrence: 1934—St. 11 (1); 1938—St. 9 (6), St. 84 (3), St. 95 (2), St. 98 (6), St. 103 (5); 1939—St. 21 (4), St. 30 (1), St. 125 (1).

9. *Atlanta pacifica* n. sp.

(Pl. XVII, Figs, D–G)

Eight specimens (1.7 mm–2.6 mm in long diameter) were measured; B/A is 0.23–0.25 (0.24 on average) and C/A is 0.10–0.13 (ca. 0.12 on average); number of whorls 4–4½ (mean number 4¼) and number of whorls on the under-side is 2–2½ (mean number between 2 and 2¼), and the height/width of the aperture is 0.54–0.78 (mean value 0.66). The keel may be slightly inserted in some specimens, for instance it encircles 1/4 of the penultimate-whorl in the 2.3 mm individual and 1/8 in the 2.5 mm individual. It is usually low, although it reaches to 440 μ in height in a 2.2 mm specimen. Spire purplish in colour, erected straightly or slightly inclined; it is more prominent than in *At. gaudichaudi*, but less remarkable than in *At. inflata*; the apical angle is 103°–116° (mean angle 108°). Shell whitish in some specimens, the base of the keel faintly brownish in some specimens. Small umbilicus may be found on some individuals.

Remarks: The present new species resembles most closely *At. gaudichaudi*. The differences between these two species are already discussed fully (pp. 242–247).

Occurrence: 1934—St. 11 (25), St. 13 (72); 1937—St. 13 (82); 1938—St. 13 (7), St. 60 (2), St. 84 (1), St. 103 (2); 1939—St. 21 (20), St. 80 (3).

There are besides four specimens; 1934—St. 13 (1), 1939—St. 77 (2) and ?1. They are, however, mutilated too much to be identified strictly.

Lastly I wish to express here my hearty thanks to Prof. H. Aikawa who gave me kindly the chance to examine the present material at the Central Fisheries Experimental Station in Tokyo in 1939.

EXPLANATION OF PLATES XVII–XVIII

PLATE XVII

Figs. A–C. *Atlanta inflata* SOULEYET. ×30.

A ··· Specimen with 2.3 mm long diameter.

A′··· Front of the same specimen.

B ··· Under-side of the specimen with 2.2 mm long diameter.

C ··· Front of the specimen with 2.5 mm long diameter.

Figs. D–G. *Atlanta pacifica* n. sp. ×30.

D ··· Specimen with 2.3 mm long diameter.

D′··· Under-side of the same specimen.

D″··· Front of the same specimen.

E ··· Specimen with 2.2 mm long diameter.

F ··· Under-side of the shell with 2.2 mm long diameter.

F′ ··· Front of the same specimen.

G ··· Front of the shell with 2.6 mm long diameter.

PLATE XVIII

Figs. H–I. *Atlanta gaudichaudi* SOULEYET.

H ··· Specimen with 2.7 mm long diameter, ×30.

H′··· Front of the same specimen, ×30.

I ··· Specimen with 2.1 mm long diameter, ×28.

I′ ··· Under-side of the same specimen, ×28.

I″ ··· Front of the same specimen, ×28.

Figs. J–K. *Atlanta fusca* SOULEYET. ×30.

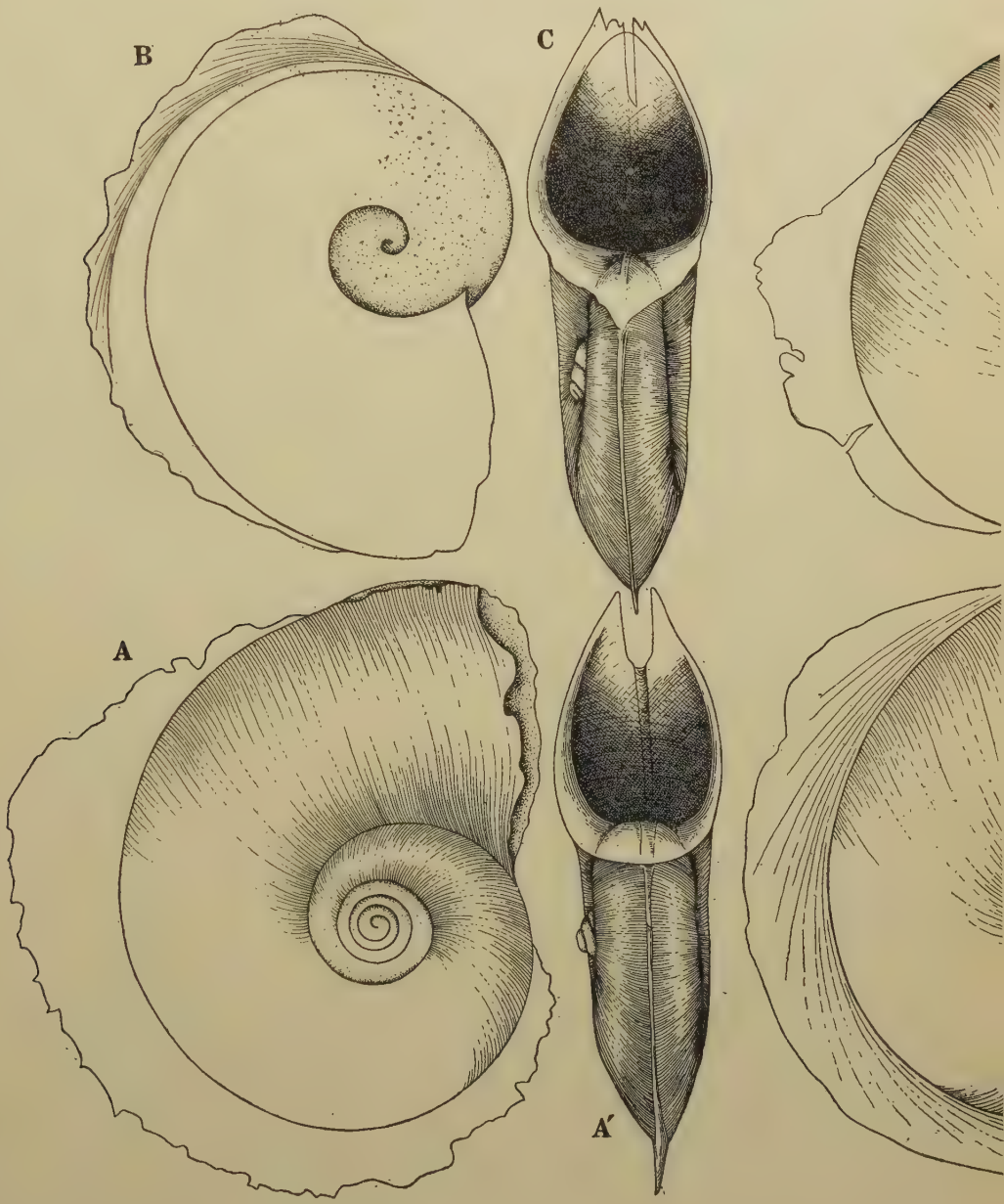
J ··· Specimen with 2.5 mm long diameter.

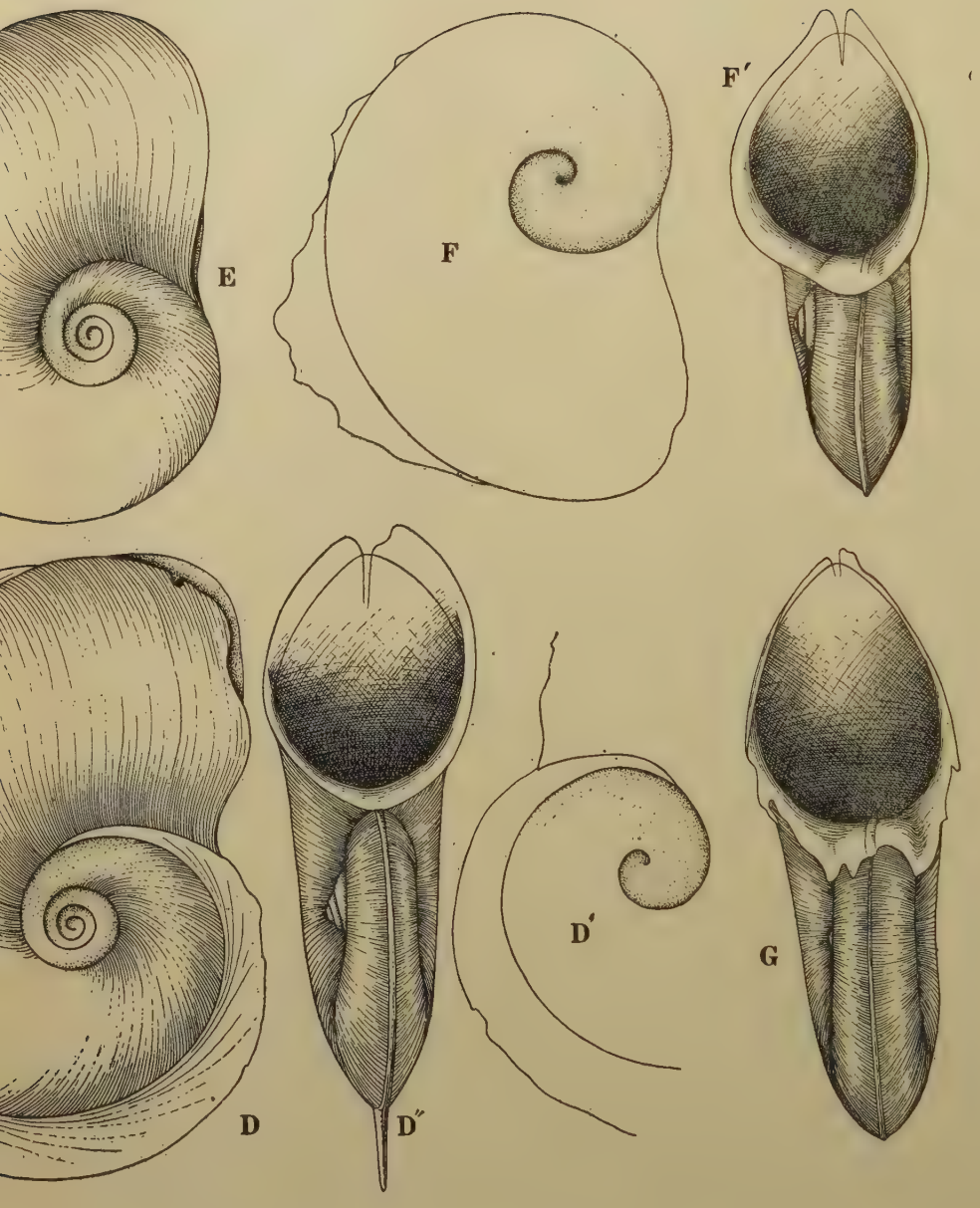
J′ ··· Under-side of the same specimen.

J″ ··· Front of the same specimen.

K ··· Specimen with 1.5 mm long diameter.

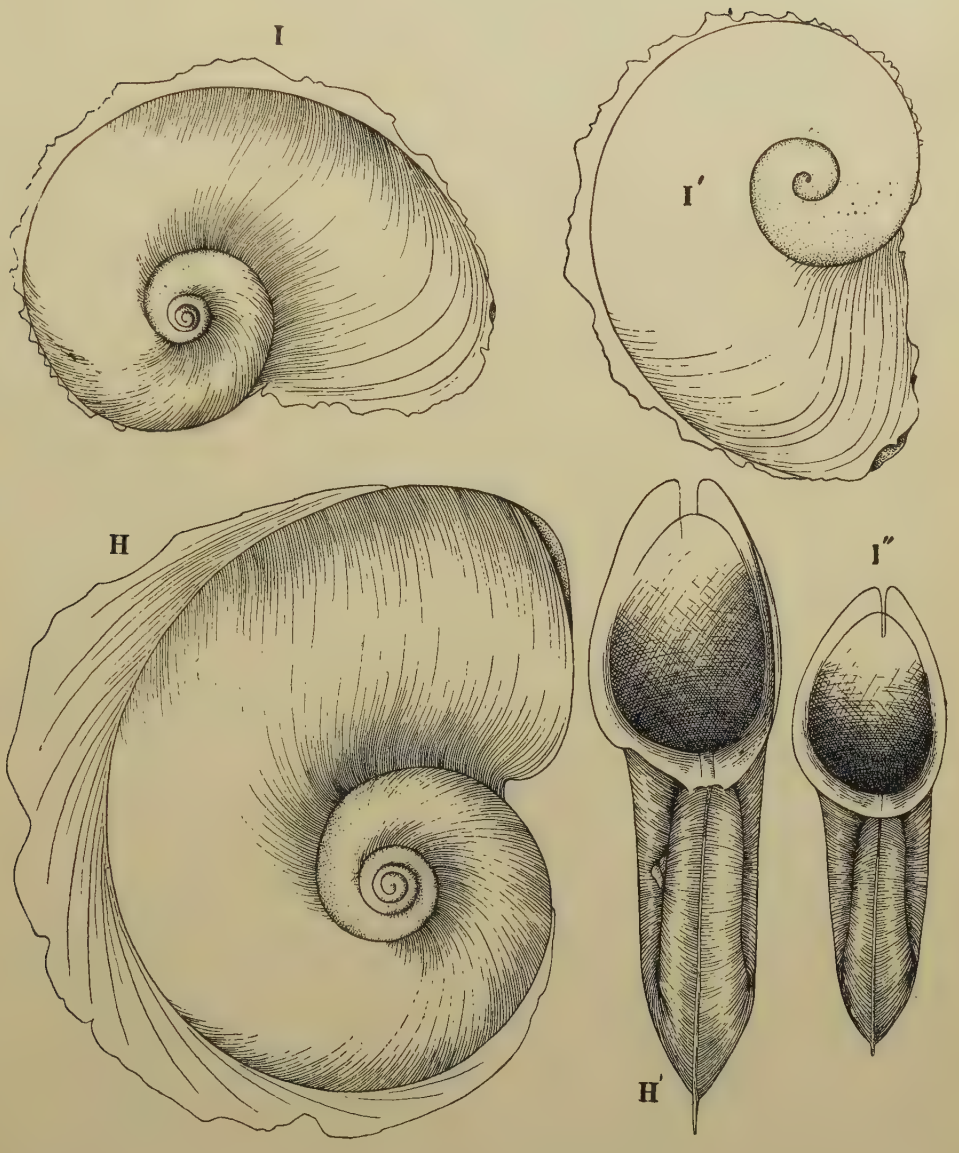
K′ ··· Front of the same specimen.

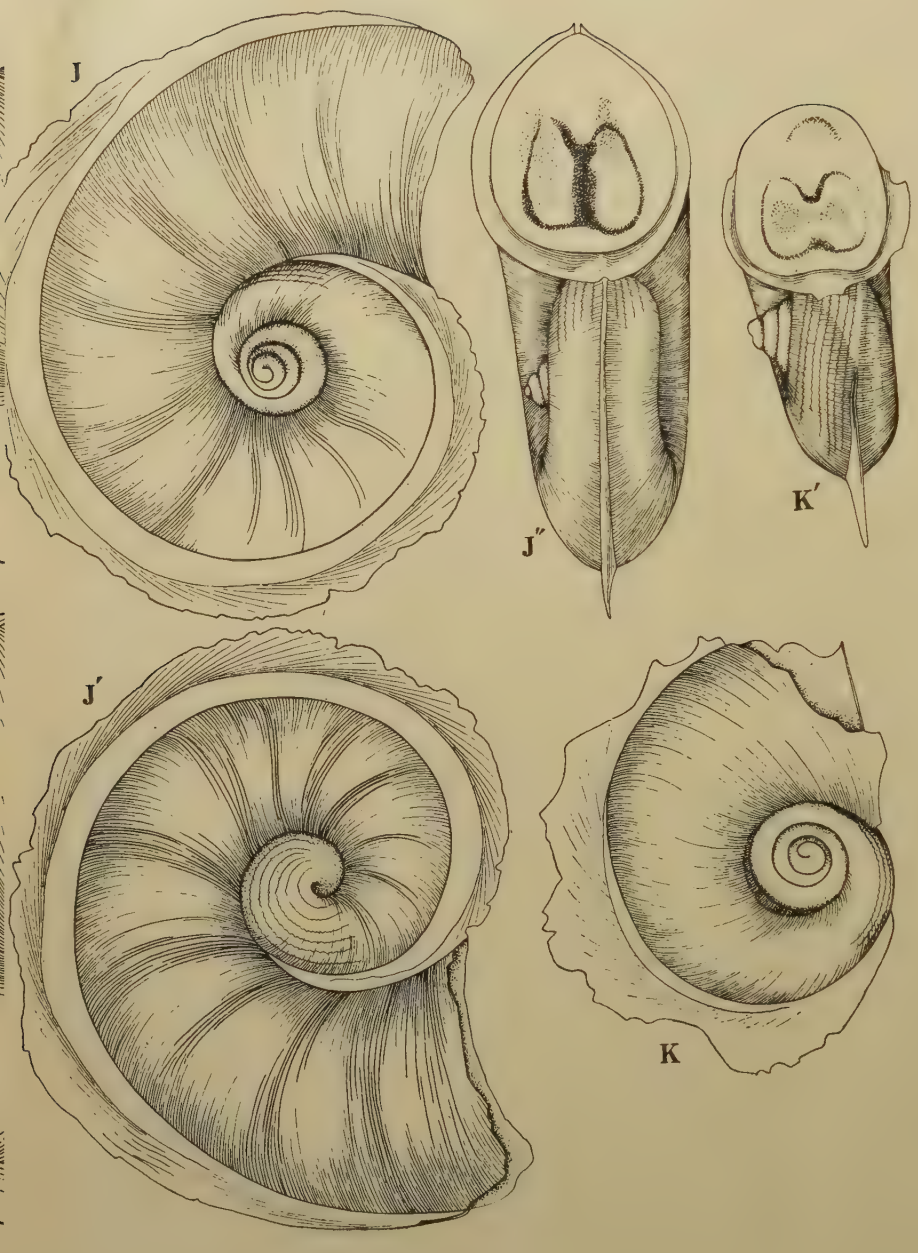

B
C
A
A'



E Collected by the Sôyô-maru.

Publ. Seto Mar. Biol. Lab., IV, 2-3 (1955)





ECTED BY THE SÔYÔ-MARU.

GENERAL CONSIDERATION ON JAPANESE APPENDICULARIAN FAUNA[1)]

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With 6 Text-figures

I. Species Occurring in Japanese Waters and the Neighbouring Seas.

So far as I am aware, the following 34 species of appendicularians are found in reports dealing with this animal group occurring in Japanese waters and the neighbouring seas.

Oikopleuridae

Oikopleura (*Coecaria*) *longicauda* VOGT (A, T_1, T_2, T_3)
Oikopleura (*Coecaria*) *fusiformis* FOL (A, T_1, T_2, T_3)
Oikopleura (*Coecaria*) *intermedia* LOHMANN (=*Oik. microstoma* AIDA) (A, T_1, T_2)
**Oikopleura* (*Coecaria*) *cornutogastra* AIDA (A, T_2, T_3)
Oikopleura (*Coecaria*) *graciloides* LOHMANN & BÜCKMANN (T_2)
Oikopleura (*Coecaria*) *gracilis* LOHMANN (T_3)
Oikopleura (*Vexillaria*) *dioica* FOL (A, T_1, T_2, T_3)
Oikopleura (*Vexillaria*) *rufescens* FOL (A, T_1, T_2, T_3)
Oikopleura (*Vexillaria*) *parva* LOHMANN (T_3)
Oikopleura (*Vexillaria*) *cophocerca* GEGENBAUR (T_1, T_2, T_3)
Oikopleura (*Vexillaria*) *albicans* (LEUCKART) (T_1)
Oikopleura (*Vexillaria*) *labradoriensis* LOHMANN (T_1, T_3)
**Oikopleura* (*Vexillaria*) *chamissonis* MERTENS (MERTENS 1831)
Megalocercus huxleyi (RITTER) (=*Oik. megastoma* AIDA) (A, T_1, T_2, T_3)
Stegosoma magnum (LANGERHANS) (A, T_1, T_2, T_3)
**Chunopleura microgaster* LOHMANN (T_1)
Pelagopleura verticalis (LOHMANN) (T_2)
**Pelagopleura* sp. (T_1, T_3)

Fritillaridae

Fritillaria (*Acrocercus*) *haplostoma* FOL (A, T_1, T_2, T_3)

1) Contributions from the Seto Marine Biological Laboratory, No. 258.

Fritillaria (*Acrocercus*) *abjornseni* Lohmann (T_2)
Fritillaria (*Acrocercus*) *magna* Lohmann (T_2, T_3)
Fritillaria (*Acrocercus*) *formica* Fol forma *digitata* Lohmann (T_1, T_2, T_3)
Fritillaria (*Acrocercus*) *fraudax* Lohmann (T_1)
Fritillaria (*Acrocercus*) *gracilis* Lohmann (T_2)
Fritillaria (*Acrocercus*) *charybdae* Lohmann (T_3)
Fritillaria (*Eurycercus*) *pellucida* (Busch) (A, T_1, T_2, T_3)
Fritillaria (*Eurycercus*) *borealis* Lohmann
forma *typica* (Lohmann) (T_1)
forma *intermedia* (Lohmann) (T_1, T_2, T_3)
forma *sargassi* (Lohmann) (=*Frit. ritteri* Aida) (A, T_1, T_2, T_3)
Fritillaria (*Eurycercus*) *megachile* Fol (T_1, T_2)
Fritillaria (*Eurycercus*) *tenella* Lohmann (T_1, T_2, T_3)
Fritillaria (*Eurycercus*) *venusta* Lohmann (T_1, T_2, T_3)
**Fritillaria* (*Eurycercus*) *bicornis* Lohmann (T_2)
Tectillaria fertilis (Lohmann) (T_1, T_2)
Appendicularia sicula Fol (T_1, T_2, T_3)
Kowalevskaia tenuis Fol (A, T_1, T_2)

Among these species, *Oik. chamissonis* is considered as being identical with *Oik. labradoriensis*; *Oik. cornutogastra* seems to be adequately treated as a form of *Oik. fusiformis* (Tokioka 1951); *Fritillaria bicornis* is undoubtedly a synonym of *Frit. venusta* as fully discussed in my previous paper (1951). *Pelagopleura* sp. (T_3) is probably an imperfectly preserved specimen of *Pel. verticalis*. *Chunopleura microgaster* reported in my paper of 1940 seems to be a decrepit individual of *Stegosoma magnum*, which has discharged all genital products out of the body. I have found, since 1940, several individuals of *St. magnum* in such state as figured and described in my previous paper of 1940 under the name of *Chunopleura microgaster*. Thus, the valid species from Japanese waters and the adjacent seas are reduced to 29 species and 3 forms.

Oik. graciloides, *Pelag. verticalis*, *Frit. abjornseni* and *Frit. gracilis* are only listed in the report given by Tokioka (1942), but there is no description nor figure of these species in any paper dealing with appendicularians in the north-western Pacific. So, I wish to give brief descriptions and sketched figures of specimens of these species found in the material under my disposal in the last section of this article, to certificate the occurrence of these animals in the neighbouring waters of Japan.

II. The Faunistic Consideration on Japanese Appendicularians.

Horizontal distribution: Japanese appendicularians may be classified conveniently as follows, as mentioned roughly in my previous paper of 1940.

1) Oceanic water form

a. Cold-water forms—*Oik. labradoriensis* in Oyasio (Tisima Current), Liman Current, cold waters along the coasts of Hokkaidô (Osyoro) and recently from the deep waters of Japan Sea under the warm Tusima Current.
Frit. borealis forma *typica* found in the northern waters of the Sea of Japan.

b. Warm-water forms—Most of the species in the list, excepting those included in groups a and 2. Among warm-water forms, *Oik. longicauda* is the commonest species and is followed by *Oik. fusiformis* and *Oik. rufescens* in Oikopleuridae and *Frit. haplostoma* is the commonest one and next *Frit. pellucida* being followed by *Frit. formica* and *Frit. borealis* f. *sargassi* and *intermedia* in Fritillaridae. AIDA (1907) says that *Kowalevskaia tenuis* is also a common visitor to the Pacific coast of Japan and is found during the summer in the swarm of *Noctiluca*, although the present species seems to be rather a rare one in my own experience.

2) Inlet-water form

Oik. dioica is found commonly and abundantly in every bay or inlet along the coasts of Japan and the adjacent regions, which holds stagnant water. This species is also found, though sparsely, in the offshore water as a drift-form from the inlet waters. In such cases, the animal seems to grow much larger than in the inlet waters. *Oik. longicauda* and *Frit. haplostoma* are frequently found in a considerable number in some bays or inlets, although it is certain that they are drifted into there from the open sea. (As to the latter species see the item of *Frit. abjornseni*.) The distribution of *Appendicularia sicula* is not certain. It is, however, a noteworthy fact that *App. sicula* is met with, in my experience, much oftener in samples from bays or inlet waters in the temperate or tropical regions than in those from the open sea.

Vertical distribution: There are merely a few data about the vertical distribution of this animal group in Japanese waters. According to my previous paper in 1951, appendicularians seem to be scarce both in the superficial layer and in the depths. I found only 3 *Oikopleura* and 1 *Fritillaria* in two samples hauled below 150 m. Of these 4 specimens, one is *Oik. longicauda* and other one is *Oik. rufescens*, while the rest can not identified clearly, because they are in a wrong state of preservation. FURUHASHI (1952) gives the following data that *Oikopleura* sp. occupied 1.4–11.1% of the whole zooplankton hauled between 140 m–400 m at two stations off San'in District.

Occurrence in swarm: AIDA (1907) reports that *Oik. rufescens* occurred once in the summer of 1897 in an exceptionally great swarm invaded the harbour of Misaki after a strong southern wind, thickly becrowding the surface water all over with cast-off "houses". I met with, once on January 31, 1949, to my own experience, a coloured stream, ca. 50 m long × 1–2 m wide, formed by fully mature individuals of *Oik. longicauda*, which appeared in Tanabe Bay not so far from the northern shore of our Laboratory. *Frit. haplostoma* occurs sometimes in a dense swarm in the superficial water near the southern shore of the Laboratory on some extremely calm days accompanied with a breeze from the south. This phenomenon seems to be produced by the same mechanism as what causes the red water of *Noctiluca* along our coasts. Namely many individuals of *Frit. haplostoma* floating in the superficial water as *Noctiluca* are blowed together by a breeze to an enormously dense swarm at some places under special topographic conditions.

III. Some Taxonomic Notes.

1. *Oikopleura graciloides* LOHMANN & BÜCKMANN, 1924

(Fig. 1)

BÜCKMANN, AD. (1923 a): Beitrag zur Kenntnis der Appendicularien. Auszug aus der Doktorarbeit, 10 s., 1 Abb.

BÜCKMANN, AD. (1924): Bemerkungen über Appendicularien aus der Ausbeute der Deutschen Südpolar-Expedition. Zool. Anz., Bd. 59.

Oikopleura californica—ESSENBERG, CH. (1926): Copelata from the San Diego Region. Univ. California, Publ. Zool., Vol. 28, No. 22.

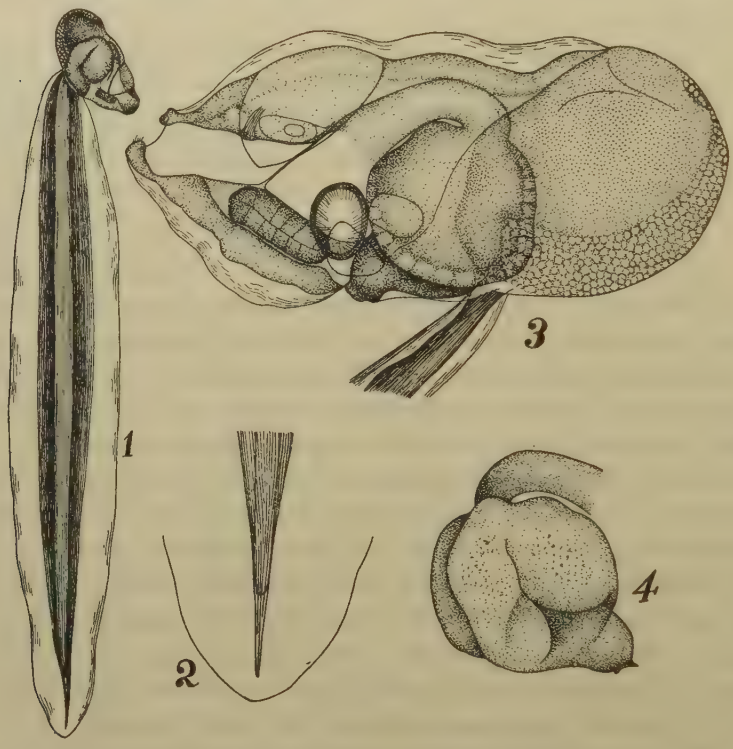

Fig. 1. *Oikopleura graciloides* LOHMANN & BÜCKMANN.
1···Entire animal; 2···Tip of tail, × ca. 45; 3···Trunk, left side, ×200;
4···Alimentary canal, right side, ×200.

Trunk: Small species. Trunk elongate ovoid, 310–430μ in length in mature state. Oral gland absent. Endostyle is short and situated much nearer the anus than the mouth. The left lobe of the stomach nearly round in outline, the oesophagus opens near the dorsal end of the stomach. Intestine short, anus situated nearly at the level of the anterior end of the mass of the alimentary canal. Gonad extends dorso-posteriorly. The antero-ventral parts of the gonad cover on each side a 1/3 or 1/2

of the mass of the alimentary organs. Ovary median.

Tail: Very long, ca. 5.5 times the length of the trunk. Tail musculature rather slender, ca. 3 times the breadth of the chorda which falls in a considerable distance from the posterior end of the musculature. Subchordal cell absent.

Locality: North and South Atlantic, the Mediterranean Sea near Messina (Lohmann 1896, 0–150 m); Bismark Archipelago (Friedrich Dahl 1896–97). Sparsely in the neighbouring waters of the Palao Islands (Tokioka 1942).

2. *Pelagopleura verticalis* (Lohmann), 1914

(Fig. 2)

Althoffia verticalis—Lohmann, H. (1914): Die Appendicularien der Valdivia-Expedition. Verhandlungen d. Deutschen Zoologischen Gesellschaft, pp. 157–192.

Pelagopleura verticalis—Lohmann und Bückmann (1926): Die Appendicularien der Deutschen Südpolar-Expedition. Deutsch. Südpolar-Exped., Bd. 18, Zool. Bd. 10.

Trunk: Rather elongate, ca. 2.2 mm in length and ca. 1 mm in width in the most perfectly preserved specimen. Endostyle is short and situated much nearer the oral aperture than the anus. Oral gland absent. Spiracles not longer than the endostyle. The alimentary canal is situated on the sagittal plane of the trunk. Stomach roughly roundish in outline, oesophagus enters the stomach at the mid-dorsal point and the intestine is issued from the antero-dorsal corner of the stomach. Ovary and testis are both paired. Testis covers the lateral side of the posterior half of the trunk, the anterior end of this organ reaches the posterior margin of the oikoplast epithelium, far beyond the stomach. Ovaries are much smaller than testes and each is situated between the testis and the alimentary canal. It is roughly a triangular plate located vertically. The posterior half extends beyond the posterior margin of the stomach and tapers to a blunt apex, while the anterior half covers the postero-ventral part of the stomach and bends outward along the anterior margin. A complex lobation occurs on the ovary in maturity and makes the shape of the latter much more complex than the general appearance described above.

Tail: Tail reaches nearly 3 times the trunk length. Tail musculature narrow, ca. two times the width of the chorda which falls far apart from the posterior end of the musculature. There are ca. 10 groups of tail-cells, each of which is rather vacuolate.

Locality: Former records are from Bengal Bay (Tiefsee-Expedition), Guinea Current (Südpolar-Expedition) and Bismark-Archipelago (Friedrich Dahl 1896–97). A few specimens were found in plankton samples hauled in the neighbouring waters of the Palao Islands (Tokioka, 1942).

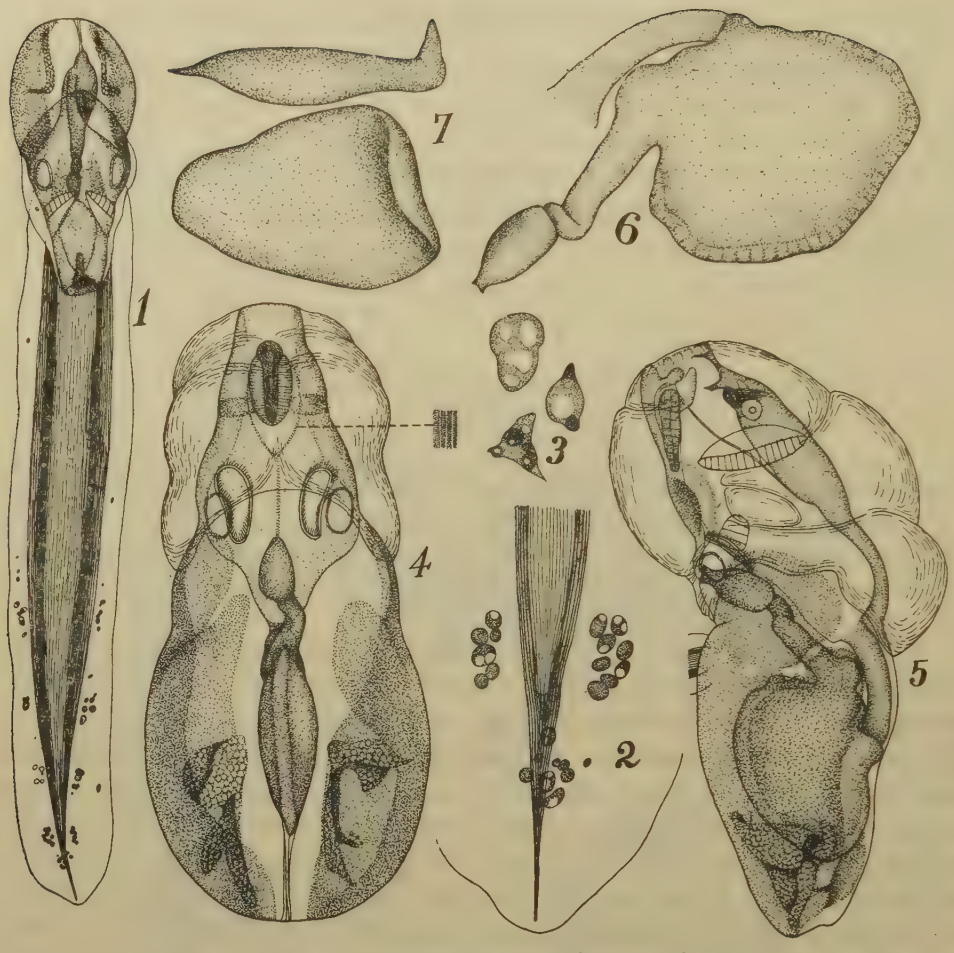

Fig. 2. *Pelagopleura verticalis* (LOHMANN).
1···Entire animal ; 2···Posterior end of tail ; 3···A part of a group of tail-cells, ×200 ; 4···Trunk, ventral side, ×40 ; 5···Trunk, left side, ×40 ; 6···Alimentary canal, left side, ×55 ; 7···Ovary. above···from ventral side. below···from outside.

3. *Fritillaria abjornseni* LOHMANN, 1909

(Figs. 3 and 4)

LOHMANN, H. (1909) : Die Fauna Südwest-Australiens. Bd. II, Lief. 10. Copelata und Thaliacea. pp. 143–149.

LOHMANN, H. und BÜCKMANN, AD. (1926) : Die Appendicularien der Deutschen Südpolar-Expedition. Deutsch. Südpolar-Exped., Bd. 18, Zool. Bd. 10.

Fritillaria lohmanni—ESSENBERG, CH. (1926) : Copelata from the San Diego Region. Univ. California, Publ. Zool., Vol. 28, No. 22.

Trunk : Small species. Trunk 440–740μ in length, 620μ on average. The fundamental structure of the alimentary and genital organs is quite the same as that of

Frit. haplostoma. The noticeable characteristics of the present species may be found only in the large and round spiracles, large ciliated groove and oikoplast epithelium extending so far back that the distance between the anterior end of the stomach and the posterior margin of the oikoplast epithelium is much smaller than the length of the epithelium itself. Ovary + testis = ca. 1/3 of the trunk length. A gland cell is situated at the postero-lateral corner of each spiracle.

Tail: About 1200μ in length. The structure is nearly the same as in *Frit. haplostoma*, although the chorda extends beyond the posterior end of the musculature only slightly and tail-cells are not found on the fin excepting a pair of small ones

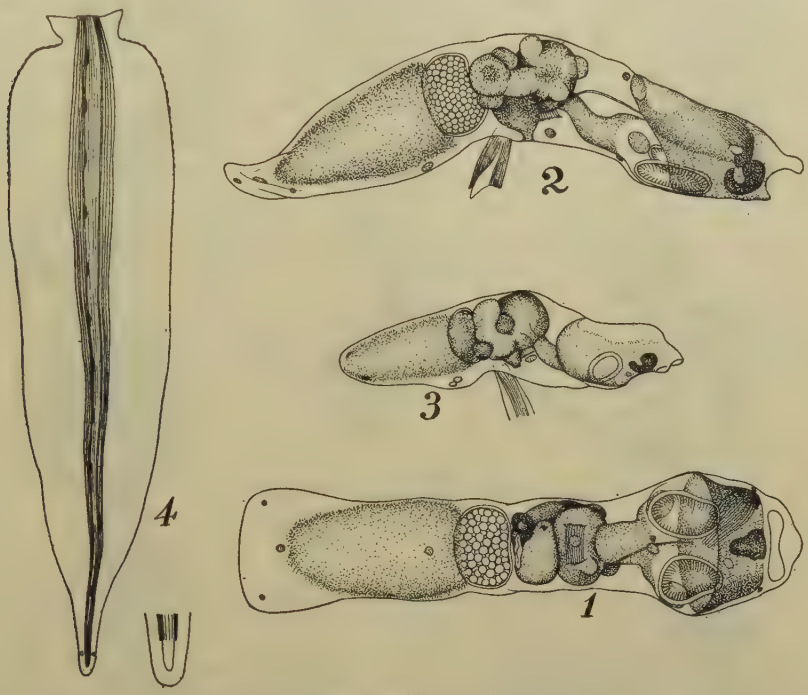

Fig. 3. *Fritillaria abjornseni* LOHMANN.
1···Trunk, ventral side, × 110; 2···Trunk, right side, × 110; 3···Trunk of the smallest individual, right side, × 110; 4···Tail. × 70

near the posterior end. The musculature is narrow, ca. 3 times the width of the chorda at the broadest portion.

Locality: A few specimens of the present species are formerly collected at the estuary of Swan River in the South West Australia and in the Antarctic with the water-temperature 1.8°C during the "Südpolar-Expedition". ESSENBERG (1926) records 2 specimens from the harbour of San Diego. From these localities, this species has been considered to be euryhaline and eurythermal. I found a few specimens in plankton samples hauled in the lagoon of the Palao Islands and in the neighbouring waters.

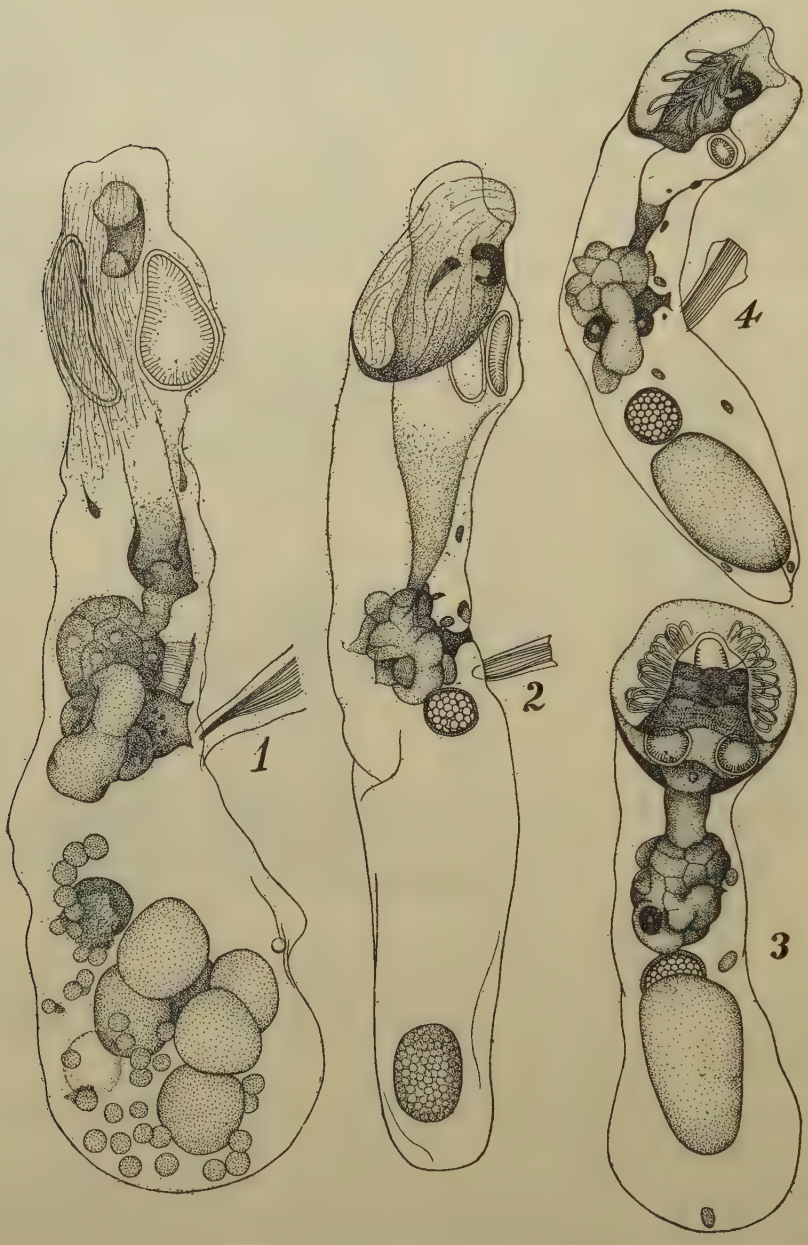

Fig. 4. *Fritillaria haplostoma* Fol.

1···Trunk of a large individual, right side; 2···Trunk of another large individual, right side; 3···Trunk of a small individual, ventral side; 4···The same, right side. all ×110.

Remarks: The Palao specimens are much larger than the original one which is only 250 μ in the trunk length (San Diego specimens are 370 μ). There is found, however, no difference in structures between the original Australian specimen and the Palao specimens which are shown in Fig. 3. It is a well known fact that *Frit. haplostoma* varies much in size as I have already mentioned in my previous paper (1951). I give in Fig. 4 figures of three individuals of *Frit. haplostoma* as the material about this problem. Figs. *1–2* in that figure show larger individuals from the oceanic waters and *3–4* in the figure indicate a small individual from the lagoon waters of the Palao Islands. The larger ones reach 1.4 mm in length of the trunk and bear large elongate spiracles. Smaller specimens are $\pm$730 μ in length of the trunk and have small round spiracles. These smaller individuals seem to occur oftener in the inlet waters than in the oceanic waters and resemble closely *Frit. abjornseni* mentioned above. The differences between these smaller *Frit. haplostoma* and *Frit. abjornseni* are as follows: 1)—Spiracles and ciliated groove are larger in *Frit. abjornseni*, 2)—The distance between the anterior end of the stomach and the posterior margin of the oikoplast epithelium is larger in *Frit. haplostoma*.

It is, however, not impossible that the differences, mentioned above, do not deserve to be considered as those of specific importance. If this supposition is allowed, *Frit. abjornseni* must be treated as an enormously small form of *Frit. haplostoma*, which is euryhaline and eurythermal and lives mainly in the coastal or inlet waters.

4. *Fritillaria gracilis* Lohmann, 1896

(Figs. 5 and 6)

Lohmann, H. (1897): Die Appendicularien der Plankton-Expedition, Ergebn. Plankton-Exped., Bd. II, Ec.

Trunk: Trunk is oval in outline, slightly compressed dorso-ventrally. It is ca. 1 mm in length and ca. 720 μ in breadth in fully mature state. Spiracles are comparatively small and round ~ slightly elongate in shape. Intestine is provided with two conspicuous glandular appendages, besides a few irregular glandular prominences. Stomach is usually quite devoid of glandular appendage, although some individuals, for instance a 660 μ long individual (Fig. 6–*1*), have a few gland cells attached to the stomach. These glandular appendages of the stomach are, however, not so large as the stomach. Testis is a U-shaped ribbon and occupies the posterior portion of the trunk. Ovaries occupy the anterior ends of the testis. Fig. 5 shows an individual, in which mature ova are scattered in the body cavity from ovaries. Fig. 6–*1* indicates an immature individual, in which the testis is interrupted medially. Such an arrangement of genital organs is considered to be common to immature individuals of *Frit. urticans* and *Frit. charybdae*. The existence of a glandular appendage on

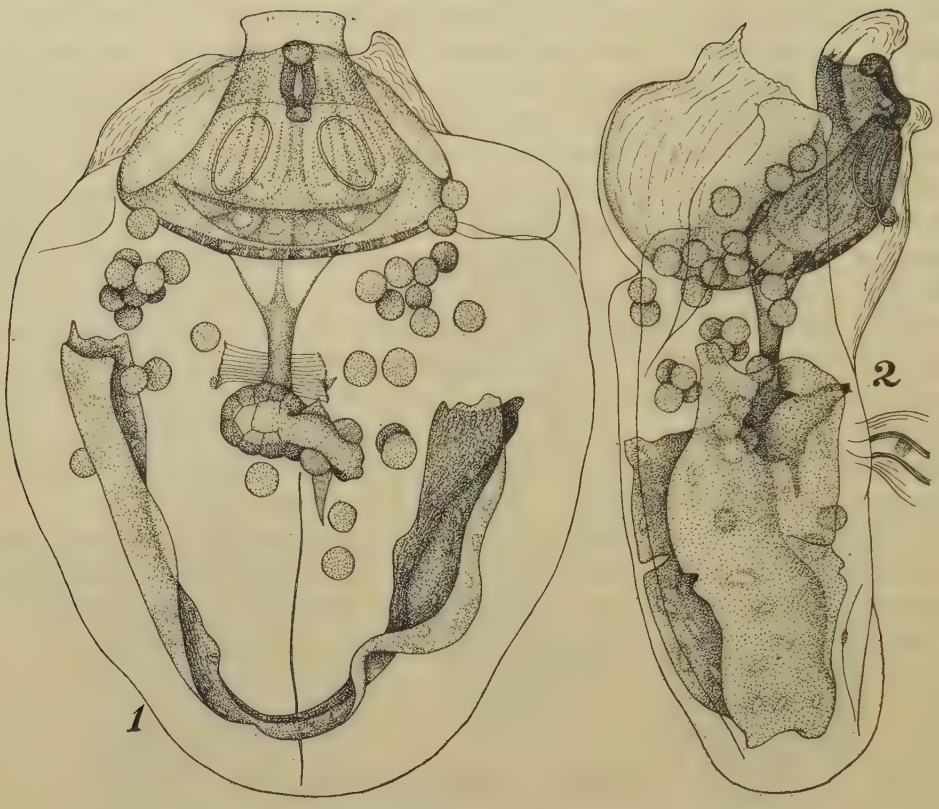

Fig. 5. *Fritillaria gracilis* LOHMANN.
1···Trunk, dorsal side, ×110; 2···Trunk, right side. ×110.

the stomach makes us very reasonably to consider the specimen as a young individual of *Frit. charybdae*. The glandular appendage is, however, much smaller than in *Frit. charybdae*. There are two distinct glandular appendages on the intestine. Spiracles small and round. The tail musculature scarcely exceeds the chorda in the width and reaches posteriorly to the posterior end of the chorda. On account of these features I prefer to treat the specimen as a young of *Frit. gracilis*, which has exceptionally a medially interrupted testis.

Tail: Ca. 1,500 μ in moderately sized individuals. As to the structure of the tail, see the preceding several lines. There are many tail-cells arranged lineally along both lateral margins of the fin.

Locality: Formerly known from the warm waters of the Atlantic and Bismark Archipelago. I got a considerable number of specimens from the stations near the Palao Islands in the North Equatorial Current.

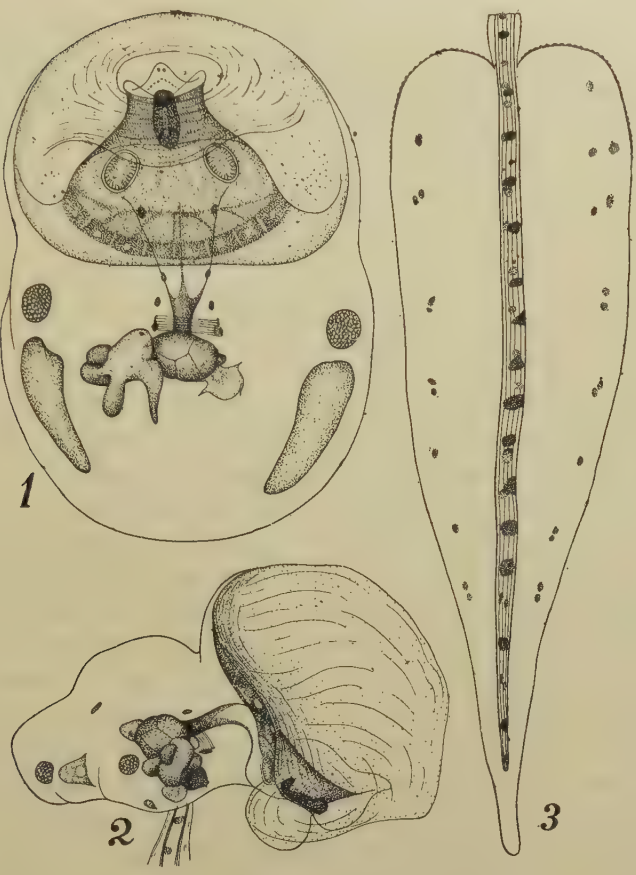

Fig. 6. *Fritillaria gracilis* LOHMANN.
1···A 660μ long trunk, ventral side, ×110; 2···A small 530μ long trunk, right side, ×110; 3···Tail, ×70.

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TWO NEW SPECIES OF *XENIA* FROM KUSIMOTO (COELENTERATA, ALCYONARIA)[1]

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With 2 Text-figures

In 1929, His Majesty the Emperor made collections of marine animals on the southern coast of Kii Peninsula during His journey to Kansai District. Among the collections were found some specimens of *Xenia*, the occurrence of which had not been anticipated at that time. All these materials are now kept in the Biological Laboratory of the Imperial Household, and have not been examined as yet.

Recently I had the opportunity to examine them through the courtesy of Dr. H. Hattori of the same Laboratory. All are preserved in the most excellent condition. On careful examination, these proved to be unable to refer to any described species of the genus, such as *Xenia hicksoni* Ashworth from Sibusi, Kagosima Prefecture and *Xenia kükenthali* Roxas from Tomioka, Kumamoto Prefecture (Utinomi, 1950). I therefore describe them as two new species, *Xenia kusimotoensis* and *X. fimbriata*.

The locality where the two new *Xenias* were obtained is shallow water near Tuya-sima, an islet between Kusimoto and Kii-ôsima, southernmost end of Kii Peninsula, which is known as one of the best collecting places along the peninsula.

Here, I wish to express my appreciation for the privilege of examining these precious materials of so much interest.

Xenia kusimotoensis sp. nov.

(Fig. 1)

Occurrence: Kusimoto near Tuya-sima, Wakayama Prefecture. Three specimens. Sp. No. Coel. 135 (Holotype and paratypes). June 3, 1929.

A single branched colony of holotype arises from a broadly expanded base of attachment, about 15 mm in maximum spread. The main stalk is columnar, about 10 mm in diameter at base and at a height of 5 mm it divides into two branches of 3 to 5 mm length. The total height is thus only 10 mm. The branches are short

1) Contributions from the Seto Marine Biological Laboratory, No. 259.

and thick, and end in dome-shaped plate from which all polyps arise.

Polyps are rather short, thick-walled and opaque; largest one measures only up to 5 mm in length, excluding the tentacles and 1–1.3 mm in diameter. The spicules are uniformly scattered all over the surface of polyps. They are mostly oblong, oval or finger-biscuit-shaped discs, measuring from 0.018×0.008 mm to 0.023×0.014 mm in size. Round discs are rare. The syndete, however, is devoid of spicules.

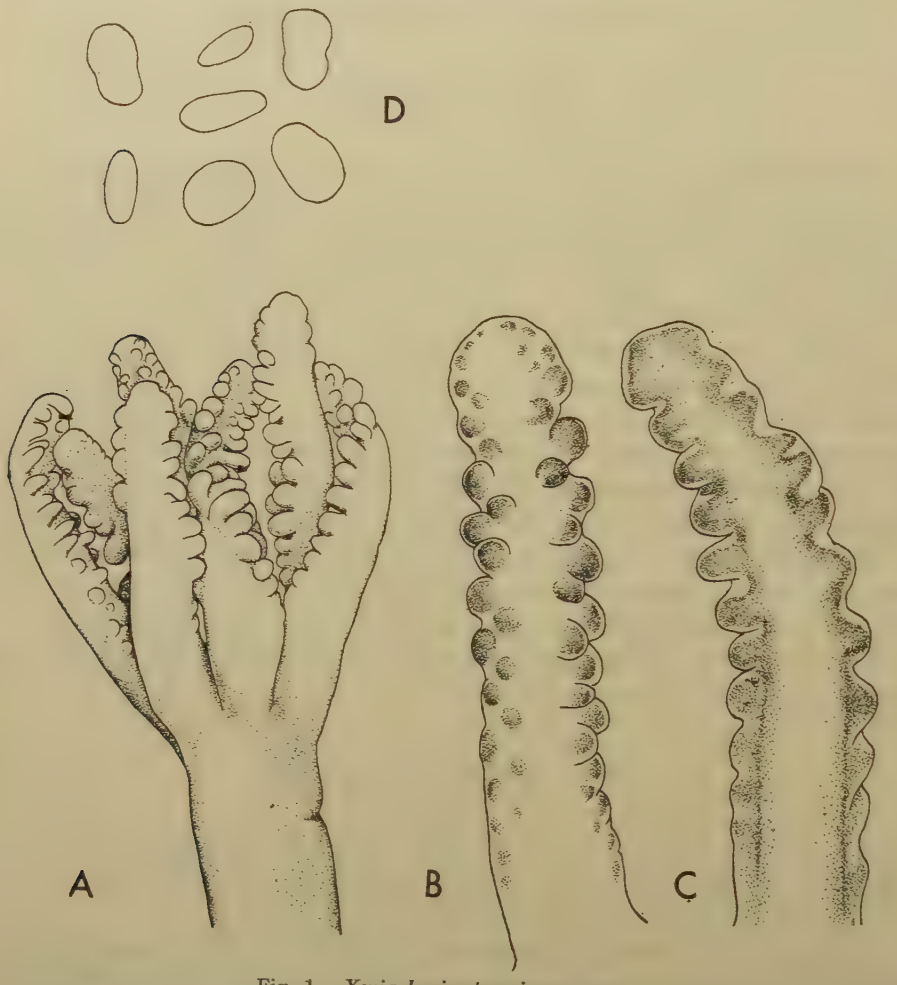

Fig. 1. *Xenia kusimotoensis* sp. nov.
A, polyp, ×18; B, tentacle, oral side, ×27; C, tentacle, aboral side, ×27; D, spicules, ×510.

The tentacles are short, compressed dorsoventrally and rounded at end. They measure about 3–4 mm long and 0.5 mm wide at base, but their length is rather irregular even in one polyp. The aboral side of the rachis is strongly convex in cross section, while the oral side is flattened and provided with two regular rows of

low conical pinnules, leaving a wide bare median region from base to end. There are about 10–12 pinnules in a row. Pinnules situated both basally and terminally are, however, merely wart-like and not paired on each side. Those in outer row are always larger than those in inner row, and largest one in the middle measures about 0.3 mm long and 0.18 mm wide. The mouth is circular, about 0.16 mm in diameter when wide open, and not raised from the oral disc. Stomodaeum about 1.5 mm long and about half as long as the tentacle.

The colour in spirit is different between the stalk and polyps. The former, together with the membranous basal expansion, is deep brown, while the latter tinged with a faint bluish colour, due to the abundance of spicules covering the surface.

Remarks: Of this genus the following species have been described to possess only two longitudinal rows of pinnules: *Xenia ternatana* SCHENK, *X. kükenthali* ROXAS, *X. lillieae* ROXAS and *X. puerto-galerae* ROXAS. According to KÜKENTHAL's key plan (1902), *X. florida* DANA and *X. danae* VERRILL also should have two rows of pinnules. HICKSON (1931) considers them only as invalid species, while ROXAS (1933) synonymizes as a valid species with three rows. In the shape and arrangement of pinnules, the present specimen most closely resembles *X. kükenthali*, but differs from the latter in the larger number of pinnules in the inner row. Furthermore this is easily distinguishable from others by the presence of spicules in the anthocodiae alone and also by the form of the colony with a lesser degree of branching.

Xenia fimbriata sp. nov.

(Fig. 2)

Occurrence: Kusimoto near Tuya-sima, Wakayama Prefecture. Two specimens. Sp. No. Coel. 136 (Holotype and paratype). June 3, 1929.

Three branched colonies of holotype arising from a common basal membrane which is irregular in outline, 10–15 mm wide and 55 mm long. They measure 8 mm, 10 mm and 12 mm respectively in the diameter of main stalk. In either one, the main stalk divides into 2 or 3 primary branches at a height of about 10 mm from the base. At their top several short and small secondary branches arise. A branch may attain a height of 25 mm from base to top. In colour the syndete and tentacles of polyps are ochraceous, but the stalk of polyps somewhat paler and transparent.

Polyps are thickly set on the top of branches and irregular in length. Most of them are tall, slender, up to 20 mm long and 1.5 mm in diameter. Tentacles also long and slender, up to 6.5 mm long and 0.6 mm wide at base. The rachis of tentacles is almost cylindrical and of almost the same diameter from base to top. The pinnules are in three very regular rows on either side of a bare median region which is wide at base and gradually narrower upwards. There are about 15 pinnules in a row. In the terminal part, however, pinnules (about 8 to 10 in number on each side) come

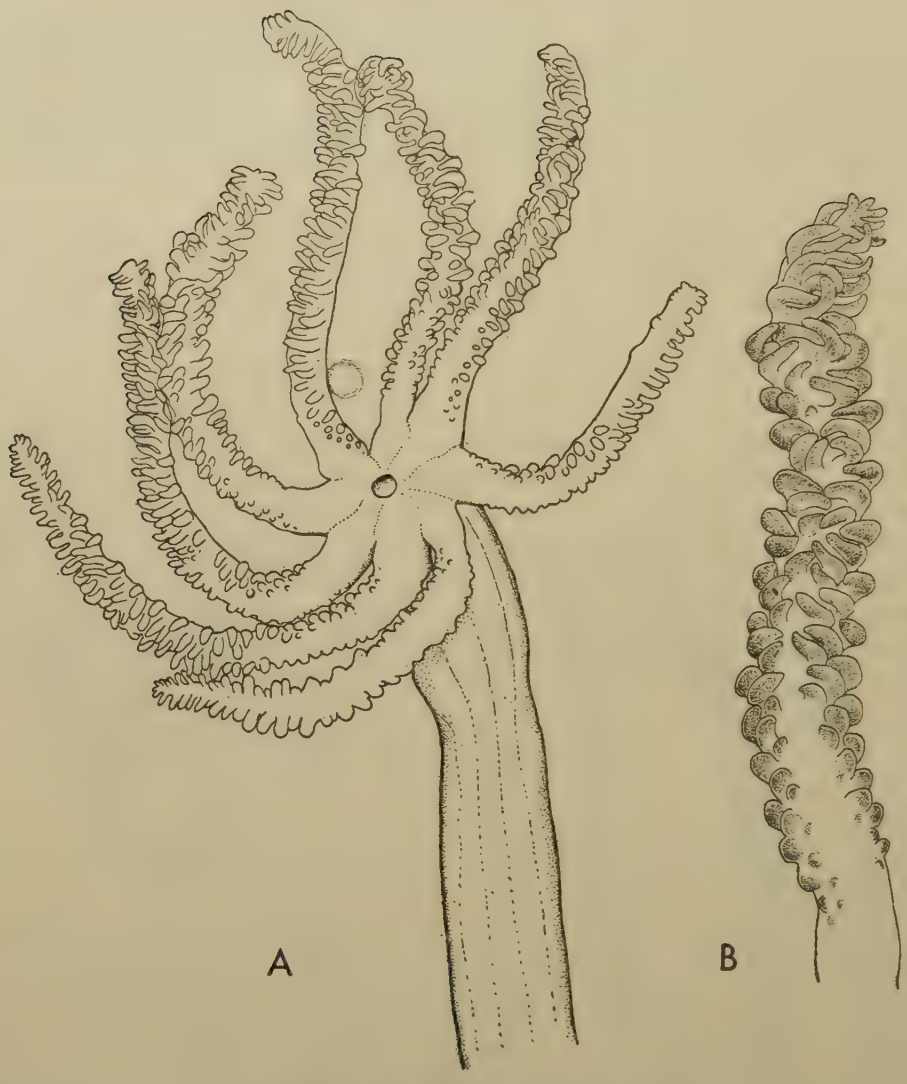

Fig. 2. *Xenia fimbriata* sp. nov.
A, polyp, ×10; B, tentacle, oral side, ×20.

together so as to form a single row on each side. These pinnules are elongate cones, more or less pointed, about 0.2–0.3 mm long and 0.08–0.09 mm wide, except for those at base which are merely wart-like. The mouth is round when wide open, depressed and about 0.3 mm in diameter. The stomodaeum is about 2.5–3.0 mm long in a full-sized polyp, that is about 1/7 to 1/8 as long as the polyp stalk.

Spicules quite absent.

Remarks: Among the species of *Xenia* lacking spicules wholly or partially,

Xenia tumbatuana MAY, *X. elongata* DANA and *X. hicksoni* ASHWORTH have been described to possess three rows of pinnules. In the general form of the colony, the present specimen resembles *X. hicksoni*, but differs from the latter by the more elongate and slender tentacles with filiform pinnules, which are arranged in three rows in the middle and in a row at end. This peculiarity does not seem to be shared with *X. elongata* and *X. tumbatuana*, the validity of which is so far inconclusive.

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PLANKTON INVESTIGATION IN INLET WATERS ALONG THE COAST OF JAPAN

VIII. THE PLANKTON OF MIYAZU BAY IN RELATION TO THE WATER MOVEMENT[1)2)]

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With 16 Text-figures

With the object of studying the plankton community in relation to the water movement, field work was made on two occasions in Miyazu Bay, a small inlet of Wakasa Bay along the coast of the Japan Sea. The first survey was made on June 3rd, 1945 and the second on September 29th, 1950. A preliminary account, dealing with the benthic and planktological data obtained during the first survey, was given elsewhere by Habe & Yamazi (MS). The present note is based chiefly on the second survey which was conducted more extensively around the area.

The zooplankton samples were vertically collected from bottom to surface at each station by a Kitahara's quantitative silk tow net stretched with No. XX–13 Müller's gauze. The diameters of the mouth and largest part of the net are ca. 22.5 cm and ca. 50 cm respectively, and the length is ca. 100 cm. The rough volume of every material was measured with a measuring cylinder by the settling method with 24 hours. For each station the total number and settling volume of zoo- and phytoplankton were calculated in each sample per 1 meter haul vertically. The standard hydrological observations such as temperature and salinity at the superficial layer, transparency and water color were made at each station. The method of treatment in examination of the material is similar to that described in my previous papers of this series.

The writer wishes to express his sincere thanks to the director and staff members of the Kyôto Fisheries Experimental Station at Miyazu for making this survey possible most effectively. This investigation was supported in part by a grant for scientific researches from the Ministry of Education.

1) Contributions from the Seto Marine Biological Laboratory, No. 260.
2) This paper has been to be expected to publish in the special volume of "Bulletin of the Biogeographical Society of Japan" in celebration of Dr. Yaichiro Okada's sixtieth birthday, but was delayed for publishing.

Hydrological Conditions

The hydrological data obtained during this survey are graphically shown in Figs. 1–6. Miyazu Bay is a small tongue-shaped inlet at the west end of Wakasa Bay facing the Japan Sea. The western and innermost area of the bay is shallow,

Fig. 1. Chart of Miyazu Bay showing the stations and isobaths.

while the eastern area is deeper than the west. Its basin has steep walls, especially in the northeastern part near the mouth, where the greatest depth reaches 30 m. A small river pours into the inner region at the head of the bay where Miyazu City lies. The western coast of the middle region of the bay forms a sand-bar known as "Amano-hasidate" and the waters of Yosa-naikai located on the west of Amano-hasidate pour into the bay through two small channels, Monju and Kirido. The general oceanographical survey of this bay was made by the Maizuru Marine Observatory (1949, 1952), MIYAZAKI (1952) and HABE & YAMAZI (MS). In the present survey, hydrological conditions such as surface temperature, salinity and catalytic activity of sea water (MATSUDAIRA 1950, YAMAZI 1953), transparency and water color were observed at 28 stations (Nos. 23 to 48) along 8 sectional lines.

The area covered in this survey is small, but, for convenience' sake, may be divided into three regions, the outer, middle and inner, the boundaries between them lying on the parallel lines along the cape Katasima-hana at the north and the cape Sisi-saki at the south.

The surface temperature (Fig. 2) varied from 21.7°C to 24.3°C, being higher in the outer region towards the eastern area of the middle region than in the inner region.

The highest salinity of the surface water was measured at the western part of the mouth, being 32.8‰. The salinity decreased from the mouth towards the innermost part along the western shore. The small decrease, on the whole, to the northeast at the equivalent latitudes may suggest the outflow of less-saline water of Yosa-naikai diluted by admixture with river drainage (Fig. 3).

The transparency (Fig. 4) and the water color (Fig. 5) were relatively large in the eastern area of the mouth and showed the gradual decrease towards the western area of the middle region. From the inner region to the eastern area of the middle region, water showed yellowish color and lower transparency.

The distribution of the catalytic activity of sea water is shown in Fig. 6. The values were smaller in the inner region and eastern area of the outer region than in the middle region to the western area of the outer region.

According to the serial oceanographic observations made by the Maizuru Marine Observatory (1949), the current is relatively strong along the western coast than elsewhere and there exists a counterclockwise current. The current is also an important factor of determining the horizontal distribution of plankton in Miyazu Bay.

Plankton

A. Quantitative Analysis of Plankton

The quantity of total plankton in the bay is shown in Fig. 7. The largest volume as well as the densent population of plankton was found in the innermost region and the eastern area of the middle region, lying from off Monju Channel to

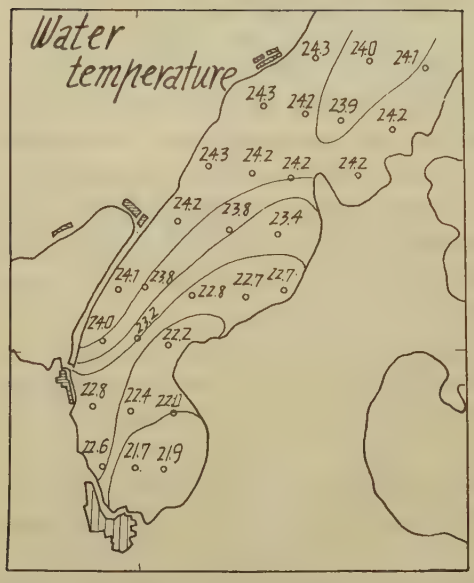

Fig. 2. Distribution of water temperature at the surface.

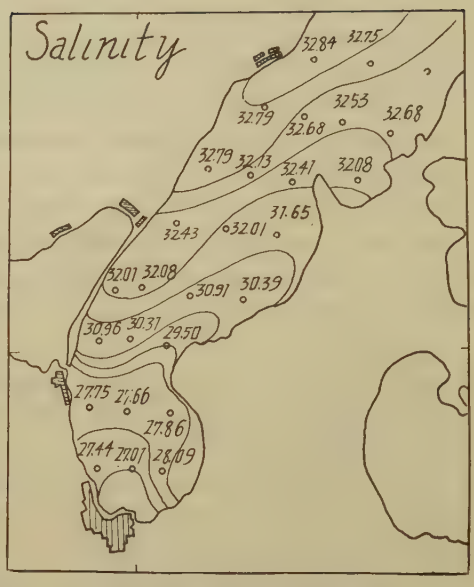

Fig. 3. Distribution of salinity at the surface.

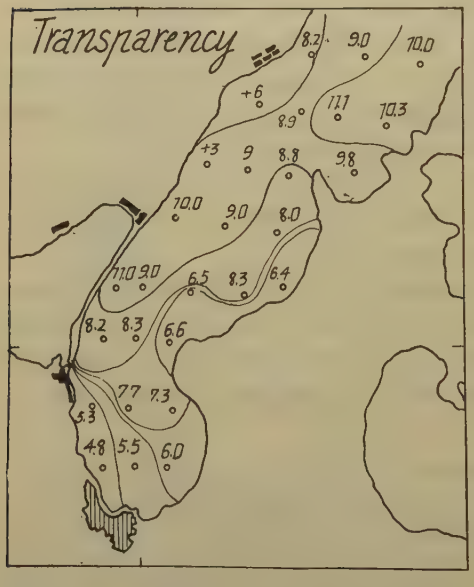

Fig. 4. Distribution of transparency (m).

Fig. 5. Distribution of water color (no.)

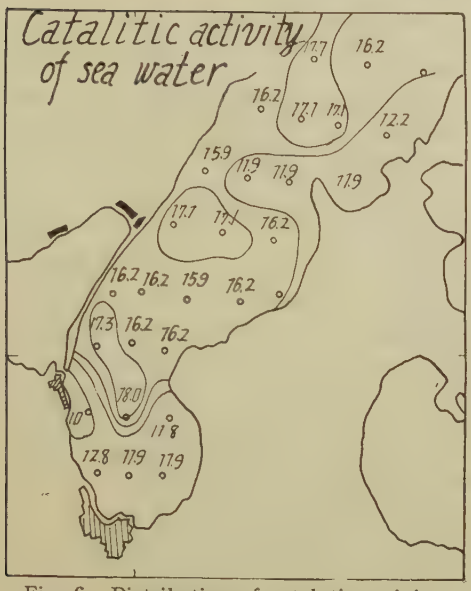

Fig. 6. Distribution of catalytic activity of sea water.

Sisi-saki. The smallest volume or population was obtained from the mouth to Amano-hasidate along the western shore of the bay (Fig. 7, A and B).

The relation between the settling volume and population density is almost the same at all stations (Fig. 8). It shows that the composition or the size of various plankton is nearly similar at all stations. At several stations (Sts. 42, 39, 38, 37 and 48), however, it is not close. This may be due to the richness of phytoplankton composition at different stations.

The zooplankton population (Fig. 9, A) was found densest in the innermost part and the eastern area of the bay, where 3–4 thousands of individuals were counted per 1 meter haul. It generally decreased

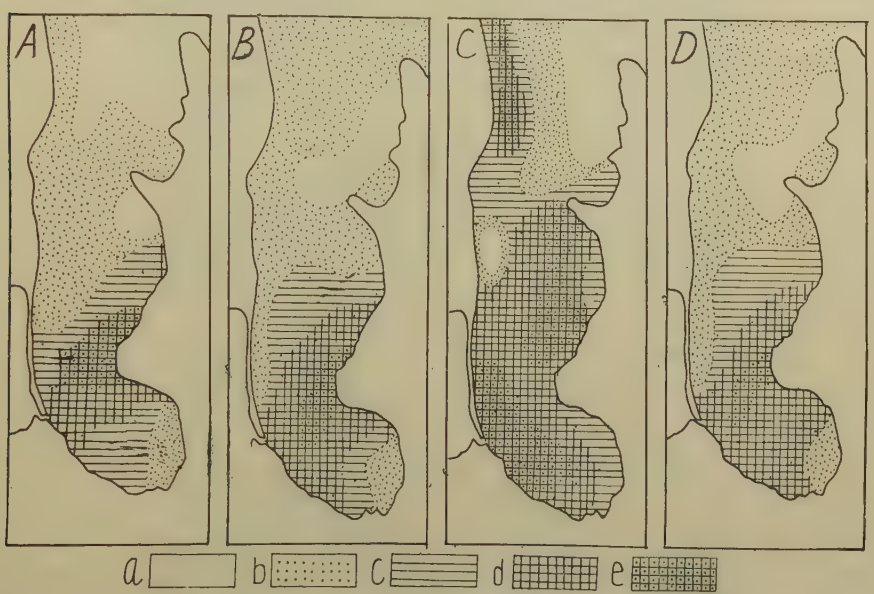

Fig. 7. A: Volume of plankton taken in vertical hauls. Number represents the cubic centimeters taken per 1 meter haul. Contour interval a, <0.1; b, 0.1–0.2; c, 0.2–0.4; d, 0.4–0.5; e, $0.5>$ cubic centimeters.
B: The distribution of the total number of plankton in vertical hauls. Number represents the cubic centimeters taken per 1 meter haul. Contour interval a, 15–16; b, 16–30; c, 30–60; d, 60–100; e, >100 individuals, cells or colonies (Unit of thousand).
C: Distribution of the total number of zooplankton per 1 meter tow. a, 500–1,000; b, 1,000–1,500; c, 1,500–2,000; d, 2,000–3,000; e, $>3,000$.
D: Distribution of total number of phytoplankton per 1 meter tow. a, 14-16; b, 16-30; c, 30–60; d, 60–100; e, >100 (Unit of thousand).

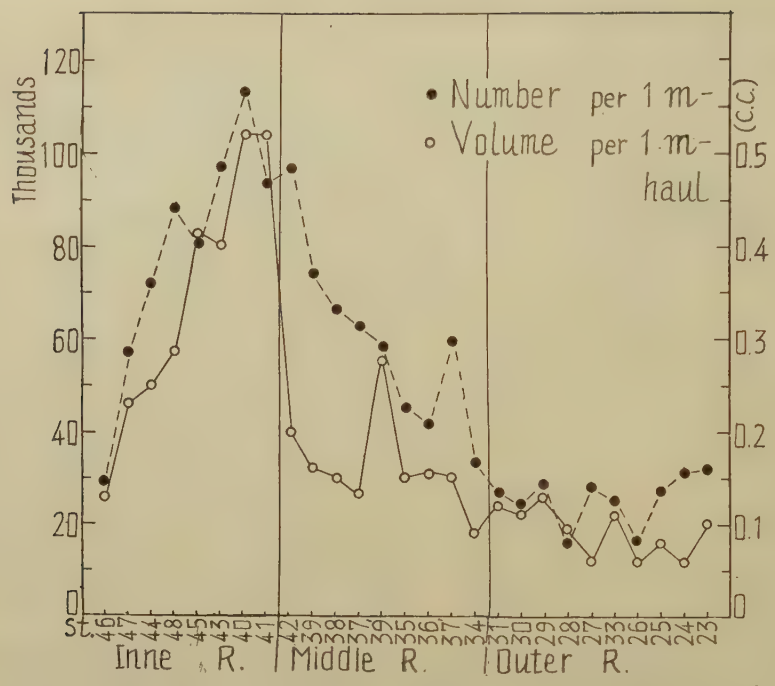

Fig. 8. The relation between the settling volume and the number of individuals, cells or colonies (each per 1 meter haul).

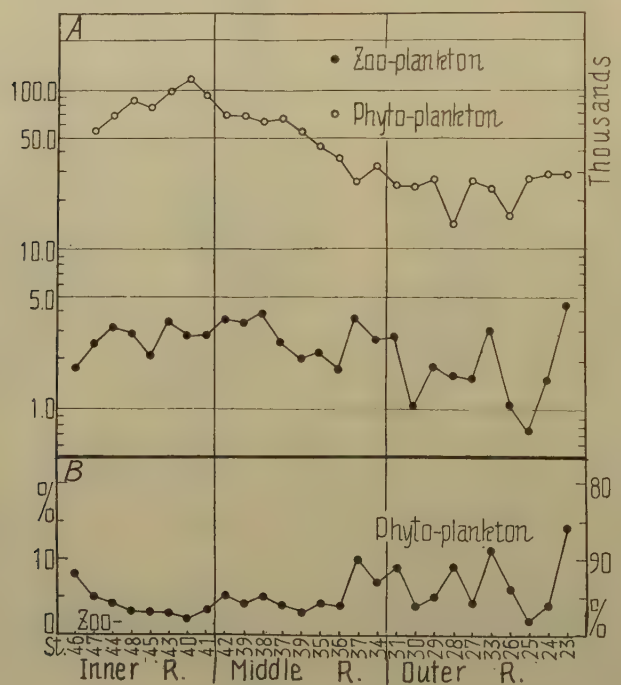

Fig. 9. A: The population of zoo- and phytoplankton per 1 meter haul. B: Percentage composition of zoo- and phytoplankton in the total plankton.

towards the western area and attained the minimum in the eastern part of the entrance. The distribution of phytoplankton (Fig. 9, A) is also in agreement. The numerical percentage of zooplankton to the total plankton (Fig. 9, B) was relatively large, 3–4 % in the inner region and 5–9 % in the outer region of the bay.

B. Qualitative Analysis of Plankton

ZOOPLANKTON:

As in other bays hitherto surveyed, the main component of zooplankton was copepod, its percentage being 60–90% of the total zooplankton, totally about 55 in species (Fig. 10). Next came the larval forms of various animals, such as polychaetes, molluscs, echinoderms and copepods, by 5–35%. The other animal groups, such as chaetognaths, tunicates, doliolids and ostracods were very few and constituted only less than 1% of the animal groups.

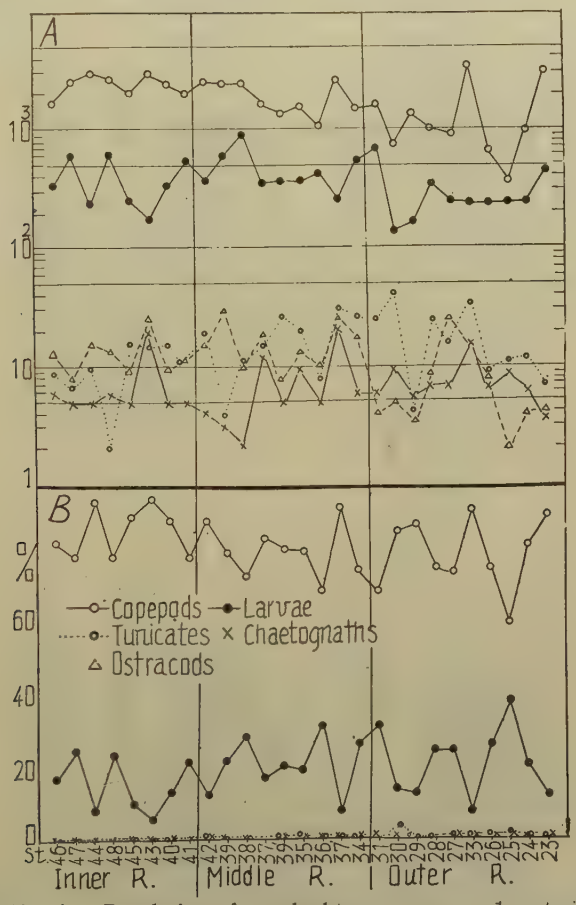

Fig. 10. A: Population of zooplankton groups per 1 meter haul.
B: The percentage composition of their groups.

Copepods: The copepods constitute the predominant group among the zooplankton. Fig. 11 shows the number and percentage composition of their important species. The component of copepods varied according to stations. *Acartia spinicauda* occurred in adundance from the innermost part to the western area of the central region, but not in the outer region of the bay, except near the western coast of the mouth where the water was somewhat slack (Fig. 12, A). *Oithona nana* was the most abundant and occupied 35–70% of the total number of copepods in the innermost part of the bay with peak number at Sts. 43 and 44, while it was very poor in the western area of the middle region and eastern area near the mouth (Fig. 12, B). The next important copepod, *Paracalanus parvus* was widely distributed in the bay, but was the most abundant in the inner region towards the eastern coast and relatively in the

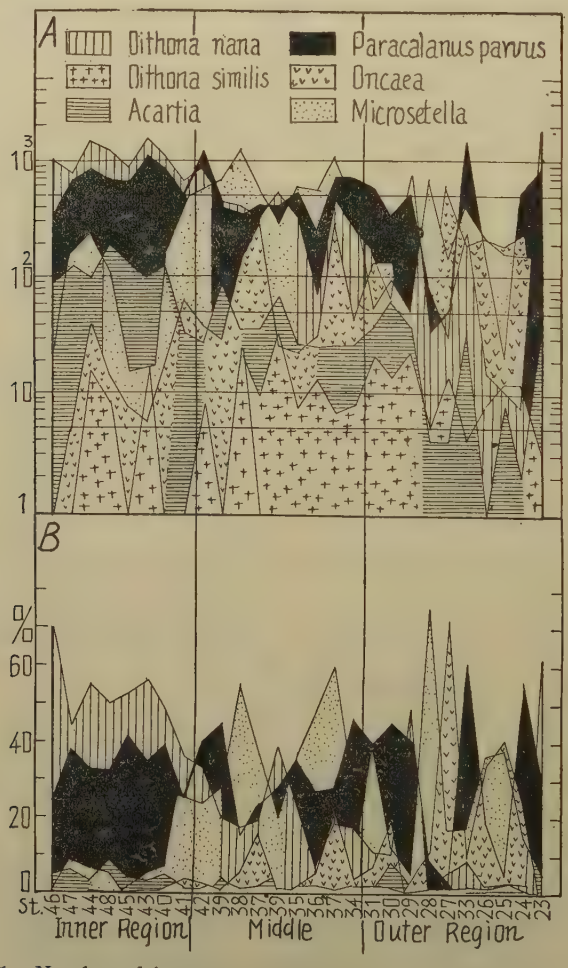

Fig. 11. Number of important copepods (A), and their percentage composition (B).

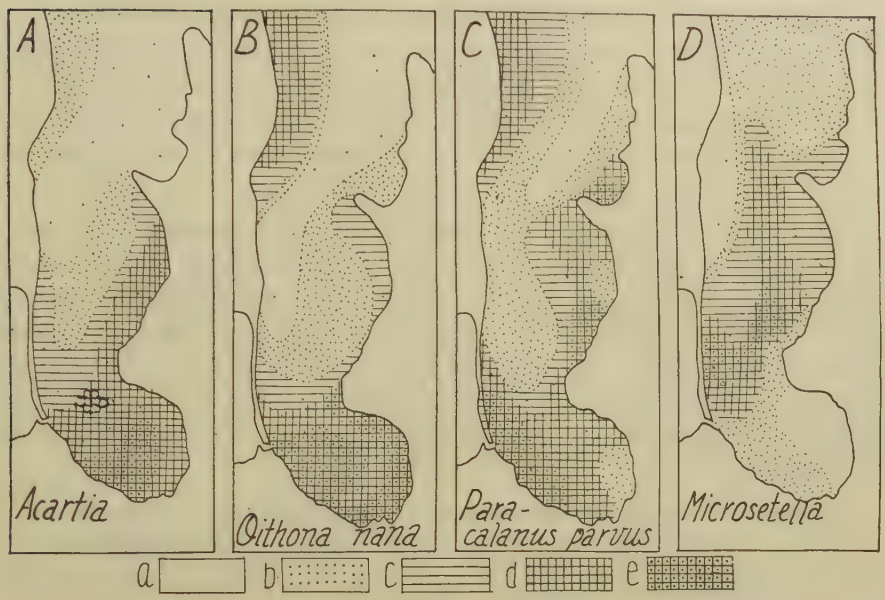

Fig. 12. Showing the distribution of the number of individuals of important copepods (each per 1 meter haul).
A : *Acartia spinicauda* a, <10 ; b, 10–20 ; c, 20–50 ; d, 50–100 ; e, >100
B : *Oithona nana* a, <100 ; b, 100–500 ; c, 500–700 ; d, 700–1,000 ; e, >1,000
C : *Paracalanus parvus* a, <100 ; b, 100–500 ; c, 500–700 ; d, 700–1,000 ; e, >1,000
D : *Microsetella rosea* a, <100 ; b, 100–300 ; c, 300–500 ; d, 500–1,000 ; e, >1,000

Fig. 13. Showing the distribution of the number of individuals of important copepods (each per 1 meter haul).
A : *Oithona similis* a, <10 ; b, 10–20 ; c, 20–30
B : *Oncaea venusta* a, <10 ; b, 10–50 ; c, 50–100 ; d, 100–500 ; e, >500

western area of the mouth, where dominated by *Oithona nana* (Fig. 12, C). Its percentage was 40–60% in the outside of the middle region except in the west, and about 40% in the innermost part of the bay. This copepods was generally found in abundance in the outer region where *Oithona nana* occurred sparsely (Fig. 12, B & C). It decreased from the eastern area of the mouth towards the western area of the mouth towards the western area of the middle region of the bay. *Microsetella rosea* was found in abundance in the central area and decreased towards the inner and outer region of the bay, and was absent in both the innermost part and western area of the outer region (Fig. 12, D). *Oithona similis* was widely distributed in the bay in a small number, but richly represented in the outer region. *Oncaea venusta* and several other species of *Oncaea* were found from the middle to the outer region of the bay and the richest in the eastern area (Fig. 13, A & B). Other copepods which appeared sparsely in the bay and brought into the bay from Wakasa Bay are listed as follows:

Species	Outer region	Inner region
Calanus darwinii	+	—
Calanus tenuicornis	+	—
Eucalanus attenuatus	+	—
Acrocalanus longicornis	+	—
Tortanus forcipatus	+	—
Temora herdmanii	+	—
Oithona plumifera	+	—
Oithona rigida	+	+
Candacia sp.	+	—
Euterpe acutifrons	+	+
Corycaeus sp.	+	—
Centropages sp.	+	+
Paracalanus aculeatus	+	—

Other animals: Of the Cladocera, *Evadne tergestina*, *Penilia schmackeri* and *Podon* sp. appeared widely but in small numbers. A small number of appendicularians represented by *Oikopleura dioica*, *O. longicauda* and *Fritillaria haplostoma* were found. The first one was widely distributed, but the other two were found chiefly in the mouth towards the western area as *Doliolum nationalis* was. The hydromedusae, such as *Solmaris*, *Liriope* and *Aglaura* were not found in the bay though scarce outside the bay. The chaetognaths were represented only by *Sagitta enflata* and *S. crassa* f. *naikaiensis*. The former species was found in a small number in the outer region of the bay, but the latter widely in all areas of the bay in a small number. Protozoans were represented mostly by the Tintinnoinea, of which *Favella campanula*, *Favella ehrenbergii*, *Tintinnopsis radix*, *Tin. beroidea* and *Helicostomella longa* were sparsely observed. The others were *Noctiluca* and several species of radiolarians.

Larval forms: The main components of larval forms were the nauplii of copepods such as *Oithona* and *Paracalanus*, which were found richer in the inner region and the eastern area than in the outer region and the western area of the middle region. The molluscan veligers, polychaete larvae, ophioplutei, auricularia, bipinnaria, echinoplutei, Müller's larvae and nauplii of 5 species of Crustacea were also found.

PHYTOPLANKTON:

About 70 important species of phytoplankton were identified. The main component was as usual the *Chaetoceros* group, which appeared predominantly in the inner region and occupied about 20–65% of the total phytoplankton. Among this group, the following *Chaetoceros* species were significant:

Species	Outer region		Middle region		Inner region
	Westward	Eastward	Westward	Eastward	
Ch. coarctatus	r	r	rr	rr	–
Ch. Eibenii	rr	rr	rr	–	–
Ch. tetrastichon	–	rr	rr	–	–
Ch. peruvianus	r	r	r	r	rr
Ch. pacificus var. *neapolitana*	rr	rr	rr	–	–
Ch. decipiens	r	r	r	r	rr
Ch. Lorenzianus	rr	rr	rr	r	r
Ch. didymus	cc	cc	cc	ccc	ccc
Ch. affinis	r	c	r	r	r
Ch. laciniosus	c	c	cc	cc	cc
Ch. laevis	r	c	c	r	rr
Ch. compressus	r	r	r	r	r
Ch. paradoxum	rr	rr	rr	rr	–

Thalassiothrix Frauenfeldii and *Thalassionema nitzschioides* came next in numerical importance and were distributed chiefly in the inner region (Figs. 14 & 15). *Biddulphia longicruris* was also important and showed a similar tendency in distribution to that of *Chaetoceros laciniosus* and *Thal. Frauenfeldii*. The other species such as *Bidd. sinensis* were widely distributed but in small numbers.

The *Rhizosolenia* group, on the other hand, was rich in the outer region than in the inner. *Rh. hebetata* f. *semispina*, *Rh. alata* f. *gracillima*, *Rh. imbricata* var. *shrubsolei* and *Rh. calcar avis* were numerous in the outer region and the western area of the middle region. *Rh. Bergonii*, *Rh. Stolterfothii*, *Rh. robusta*, *Rh. setigera*, *Rh. alata* f. *indica* and *Rh. acuminata* were also found, showing a similar distribution.

Other important diatoms were the species, such as *Stephanopyxis palmeriana*, *Leptocylindrus danicus*, *Dactyliosolen antarcticus*, *Guinardia flaccida*, *Cos. excentricus*, *Cos. Granii*, *Cos.* sp., *Hemiaulus Hauckii*, *Climacodium biconcavum*, *Clim. Frauenfeldianum* and *Ditylum sol.*

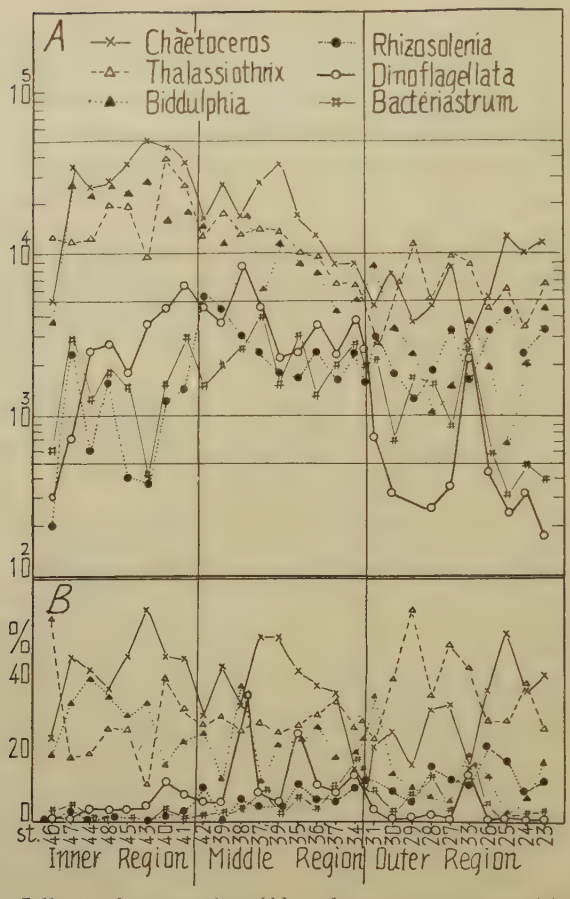

Fig. 14. Cell or colony number (A) and percentage composition (B) of important phytoplankton.

Dinoflagellates were rather unevenly distributed in the bay. Among them, *Cer. fusus*, *Cer. furca*, *Cer. pennatum*, *Cer. tripos*, *Cer. trichoceros* occurred rather abundantly and were the richest in the middle region. The other species such as oceanic forms *Cer. macroceros*, *Cer. carriense*, *Cer. palmatum*, *Cer, candelabrum*, *Cer. berone*, *Ceratocoris horrida*, *Pyrophacus horologicum*, *P. hamulus* var. *inaequalis*, *Pyrocystis noctiluca*, *Amphisolenia bidentata*, *Dinophysis homunculus* and *Peridinium grande* were scarcely found in the outer region and the western area of the mindle region. These species may be immigrants from the Wakasa Bay. *Prorocentrum micans* and *Per. oceanicum* var. *oblongum* were evenly distributed in small numbers.

Discussion

General Consideration on Regional Distribution

Although Miyazu Bay is a narrow inlet forming a branch of Wakasa Bay on the

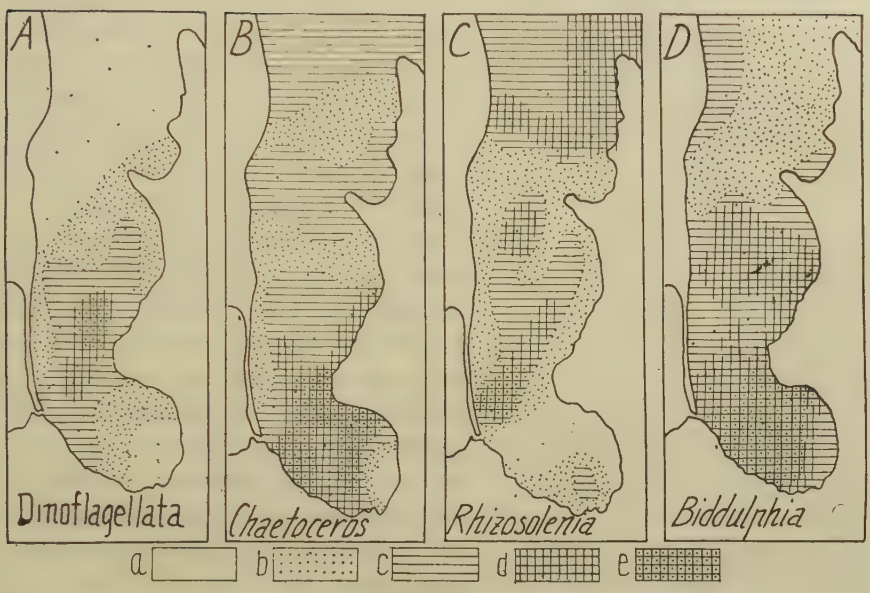

Fig. 15. Distribution of important phytoplankton groups (each per 1 meter haul).
A: Dinoflagellata a, <500 ; b, 500–1,000 ; c, 1,000–4,000 ; d, 4,000–8,000 ; e, >8,000.
B: *Chaetoceros* a, 1,000–5,000 ; b, 5,000–10,000 ; c, 10,000–20,000 ; d, 20,000–30,000 ; e, >30,000.
C: *Rhizosolenia* a, <1,000 ; b, 1,000–2,000 ; c, 2,000–3,000 ; d, 3,000–4,000 ; e, 4,000–5000.
D: *Biddulphia* a, <3,000 ; b, 3,000–5,000 ; c, 5,000–10,000 ; d, 10,000–20,000 ; e, 20,000–30,000.

Japan Sea coast and has a simple form especially along the west coast, the hydrological condition of the bay varies greatly between the western, eastern and southern inner areas. The basin of the northern region of the bay is shallower westwards, and the water decreases in salinity eastwards and more conspicuously inwards and clearer along the west coast than on the east. This suggests that the open sea waters of Wakasa Bay flow into this bay along the west coast, and then flows eastwards in the inner region, as mixed with less-saline water from the river drainage. Thus it may be understood that in this bay area exists a weak counterclockwise circulation (Maizuru Oceanographical Observatory, 1949, 1952). Topographical and hydrological conditions exert a directive influence to the distribution of the plankton communities.

As the water movement indicators of this bay the following four species of copepods seem to be the most significant: *Oithona nana*, *Paracalanus parvus*, *Microsetella rosea* and *Oncaea venusta* (Fig. 16).

Fig. 16. Distribution of dominant copepods in Miyazu Bay.
a, *Paracalanus parvus*; b, *Oithona nana*; c, *Microsetella rosea*; d, *Oncaea* spp.

1. *Oithona nana* area.

The inner region and the east coast area of the middle region were densely occupied by the small copepod *Oithona nana.* Next *Paracalanus parvus* was also numerous. Its population density was the largest in the inner region, constituting more than 50% of the total copepods. These areas of the bay were thus evidently predominated by *Oithona nana* and *Paracalanus parvus* whose distribution extends far out of the bay. *Acartia spinicauda* was confined to protected waters of the innermost area where polluted with less-saline waters from rivers and the stagnated lagoon, Yosa-naikai. A large number of diatoms such as *Chaetoceros, Biddulphia* and *Thalassiothrix* were also abundant, but dinoflagellates and *Rhizosolenia* were rather poor in number and species.

2. *Paracalanus parvus* area.

The area between the inner and middle region to the east coast of the middle region, was dominated by *Paracalanus parvus.* In this area, *Oithona nana, Microsetella rosea* and *Oncaea* were also abundant, though not so large as *Paracalanus parvus.* The water in this area is more or less stagnant and more saline than in the innermost region, dominated by *Oithona nana.*

3. *Microsetella rosea* area.

Most of the middle region especially along the shore of Amano-hasidate was occupied by the *Microsetella* community most abundantly. *Oncaea venusta, Oncaea* spp. and *Rhizosolenia* were rather abundant. The offshore animals, diatoms and dino-flagellates were found sparsely. The water of this area is also relatively stagnant but shows higher salinity than in the above-mentioned area.

4. *Oncaea* area.

The eastern area of the outer region was characterized by the predominance of *Oncaea venusta* and *Oncaea* spp. over the other inshore organisms. Several offshore copepods, *Oithona similis, Doliolum* sp. and *Fritillaria* sp. were also found at each station, and here their quantity was small but abundant in number of species. The outer region is influenced strongly by the influx of the open waters, with high salinity and transparency, lower class of water color.

Zooplankton and its Relationship to Current

The movement of the water-mass itself may profoundly affect the distribution and population of the plankton, though it is carried with the water when the water-mass moves. The use of plankton as indicators of various water-masses and their movement has been fully discussed by many workers in the English Channel (RUSSELL, 1935, 1936), Gulf of Maine (REDFIELD and BEALE, 1940; REDFIELD, 1941) and Sea of Japan (YAMAZI, 1953).

According to the oceanographical observations sometimes made by the MAIZURU MARINE OBSERVATORY (1949, 1952, 1952 a) in Miyazu Bay, there is a weak counter-clockwise circulation within the bay in respect to the surface current or non-tidal drift. This circulation is augumented by the inflow of the open sea water along the western shore across the area off the cape Kuro-saki. The inflow is relatively barren in oceanic plankton and does not provide good conditions for development and reproduction of plankton till mixing with the more sheltered waters. The plankton animals are thus crowded together in relatively quiescent waters of the inner region of the bay, where both *Oithona nana* and *Paracalanus parvus* are dominant. Their dense population in the southwestern area of the inner region extended northeastward to the cape Katasima-hana along the east coast, and thereabout a part may be caught in the recurrent drift near Sts. 34, 32 and 35, and carried again southward in the inner part of the bay (Figs. 7, 12 and 13).

It is evident that the distribution of plankton population indicates the water movement of the bay. In conclusion it should be pointed out that some of the important littoral copepods can be used not only as indicators of water movement in solving some of hydrographic problems but also to help in understanding the very complex minor factors affecting the biomass, even in such a restricted or small area as the inlet waters, as done by most of the earlier workers in the offshore waters.

Summary

1. On September 29th, 1950, the second survey was made in Miyazu Bay to study the plankton community in relation to the water movement. The hydrological data and the fluctuations of the plankton communities obtained quantitatively and qualitatively were described.

2. The variation of the plankton distribution was closely correlated with the circulation, deduced from the hydrological and planktological observations.

3. The regional distribution of plankton was discussed. On the basis of the regional abundance of some important copepods, Miyazu Bay can be divided into four ecological areas dominated by: (1) *Oithona nana*, (2) *Paracalanus parvus*, (3) *Microsetella rosea* and (4) *Oncaea*, respectively.

4. The principal factor affecting the quantitative and qualitative distribution of zoo- and phytoplankton is a complex between the inflow of relatively barren open sea water and the outflow of fertile bay water.

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PLANKTON INVESTIGATION IN INLET WATERS ALONG THE COAST OF JAPAN

XVI. THE PLANKTON OF TÔKYÔ BAY IN RELATION TO THE WATER MOVEMENT[1)]

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With Plates XIX–XX and 22 Text-figures

General oceanographical observations of Tôkyô Bay were already made by Kobe Marine Observatory (1931). After the war, the Central Fisheries Experimental Station made also the oceanographical and biological surveys with special reference to the productivity (Hanaoka *et al.*, 1947–1950; Hanaoka, 1952). The planktological communities of the bay have been studied by Aikawa (1936), Fujiya (1952) and Shimomura (1953). The benthic communities have been studied by Masui (1943), Kawaguchi (1946), Shimazu and Yamane (1948) and Habe (1952).

The present paper deals mainly with the regional distribution of the plankton with reference to the hydrological environment, and comments on the surface water mass movements of the bay are made from the planktological viewpoint. The materials and oceanographical data on which the present paper is based owe to the investigations by Hanaoka *et al.* (1947–1950).

I want to express my sincere gratitude to Dr. T. Hanaoka, director of the Naikai Regional Fisheries Research Laboratory, who made it possible for me to use plankton material and supplied me with the necessary hydrological data for the period of the survey.

The materials on which the present paper is based were collected between the 4th to 9th of July, 1948, by means of Kitahara's quantitative tow-net with Müller gauze No. 13, 22.5 cm in diameter of mouth and 50 cm in that of the widest part, as hauled vertically from bottom or 50 m to the surface. Among plankton organisms, chaetognaths will be described fully in another paper by Mr. A. Murakami of the Naikai Regional Fisheries Research Laboratory. The plankton volume of each sample was measured after settling of 24 hours. All plankton figures and data imply the volume or number per one meter haul. The stations are shown in Fig. 1.

1) Contributions from the Seto Marine Biological Laboratory, No. 261.

General Hydrological Conditions

Tôkyô Bay has an area of about 1,187 km^2, a volume of about 16.1 km^3 and an average depth of about 13.9 m in the inner part. As shown in Fig. 1, the inner region of the bay is relatively shallow, less than 40 m, and the basin is inclined more slowly on the east than on the west. On the contrary the outer region or the entrance of the bay, namely "Uraga-suido", is much deeper, more than 500 meters at the central part forming a drowned valley. The bay receives several large rivers, Sumida-gawa, Edo-gawa and Naka-gawa at the head, and several relatively smaller rivers at the western coast, and the coastal area thus shows very small transparency, low salinity, brown color and is highly polluted by industrial sewage. According to data given by HANAOKA *et al.*, the general hydrological conditions of Tôkyô Bay are as follows:

Fig. 1. Map of Tôkyô Bay, showing stations and bathymetric contours.

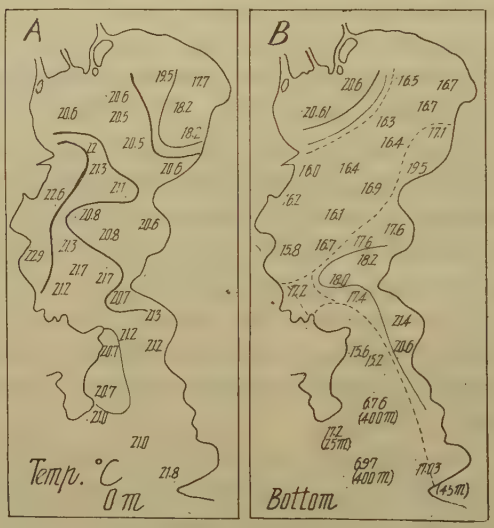

Fig. 2. Water temperature of the surface (A) and of the bottom (B) during July 4-9, 1948 (after HANAOKA, 1950).

Water temperature (Fig. 2): The water temperature at the surface is usually influenced by the air temperature. The surface temperature was between 18°C to 22.9°C. It reached the minimum at the northeastern head and became larger southwestwards. The maximum values were found near Yokohama Harbour. The water temperature at the bottom was lower than the surface. Its range was very large, being from 6°C (in 400 m depth near the mouth) to 21. 5°C. It was lower in the middle and western areas from the mouth to the central region than in the east, and

it was also lower in the eastern area than in the western in the inner region of the bay. These lower temperature is correlaed with the influx of open sea waters.

Chlorinity (Fig. 3): The chlorinities in the inner and central region of the bay showed a close correlation with freshwater drainage, ranging between about 10–18‰ at the surface. The lowest value at the superficial layer was found off Tôkyô Harbour, where the estuarine water is mixed with drainage and sewage. In the subsurface waters the chlorinity showed a smaller range. Generally it was higher towards the south and east. At the northeastern corner of the inner region off Tiba, the surface chlorinity was very high as a result of progressive dilution by upwelling water from subsurface layers. In the entrance of the bay, the surface chlorinity was also high with a small range.

Currents (Fig. 4): The schematic current diagram obtained by KOBE MARINE OBSERVATORY (1931) is shown in Fig. 4. According to current observations there exist two anticlockwise currents in the inner region. The current seems to be an important factor of determining the plankton distribution, because it controls the ecological conditions. This phenomenon will be discussed later on.

Transparency (Fig. 5, A): Transparency was smaller at the northwestern corner off Tôkyô Harbour, measuring 2–2.5 m, than in the other area. This area is shallow and much polluted. This is due to the shallowness of the basin and pollution by freshwater and sewage from the neighbouring. In the entrance of the bay, however, the water is more transparent, being from 8 to 10 meters.

Water color (Fig. 5, B): The water color of the western half in the central region showed no. 8 of FOREL's scale. The water near Tôkyô was too turbid to be measured by the FOREL's scale, while towards the eastern coast it becomes clear, showing nos. 5–6 and out of the bay it showed nos. 4–5.

Oxygen content (Fig. 6): The oxygen content is largely affected by the biological conditions in various parts of the bay. In this survey the oxygen content was large at almost all stations especially in upper layers. It was smaller at the head of the bay, both the surface and bottom. The highest value existed in the central region, where the saturation degree was greater than 120% at the surface, and even in the bottom it was more than 70%. The distribution of the oxygen content was correlated with the phytoplankton populations.

Silicates (SiO_2) (Fig. 7): In general, the concentration of silicate found in the inner region was higher than in the central and outer region. Along the northern and western coast of the inner region where the river waters pour into, the silicate showed 100–3,000 mg per m^3, and decreased towards the offing. In the outer region it was only slightly traceable. As shown in Fig. 7, B and C, the silicate content in the central region was fairly uniform from surface to bottom. In the deeper layer also it was higher in the inner region as in the surface layer.

Phosphates (P_2O_5) (Fig. 8): The phosphates at the superficial and 8–10 m layers was very low throughout the stations. The relatively higher values were found at the bottom, especially in the outer region of the bay.

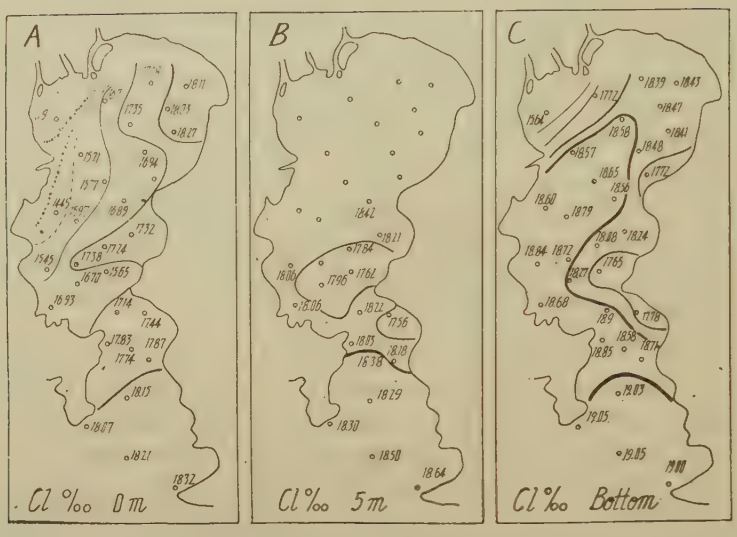

Fig. 3. Distribution of chlorinity of the surface layer (A), of the 5 m layer (B) and of the bottom (C).

Fig. 4. Stream lines of the circulations of water in Tôkyô Bay determined by the current observations and the distribution of water masses during spring, 1929 (after KOBE MARINE OBSERVATORY, 1931).

——→ inlet water - - - - → open sea water.

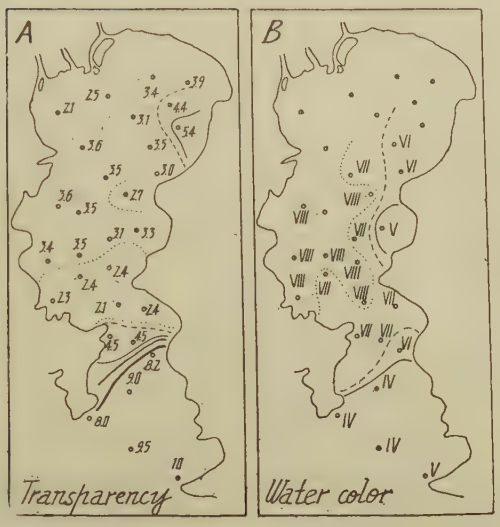

Fig. 5. Distribution of transparency (A) and water color (B) during July 4-9, 1948.

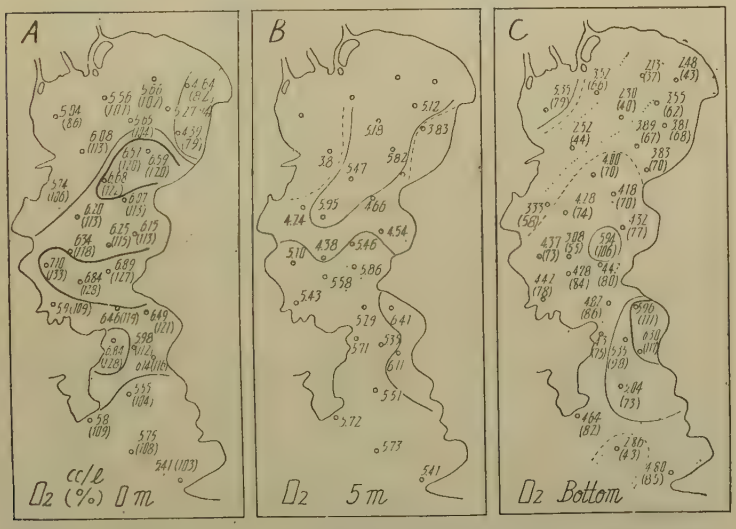

Fig. 6. Distribution of oxygen content (cc/1) and saturation degree (%) (indicated in parentheses) of the superficial layer(A), of the 5 m layer (B) and of the bottom (C).

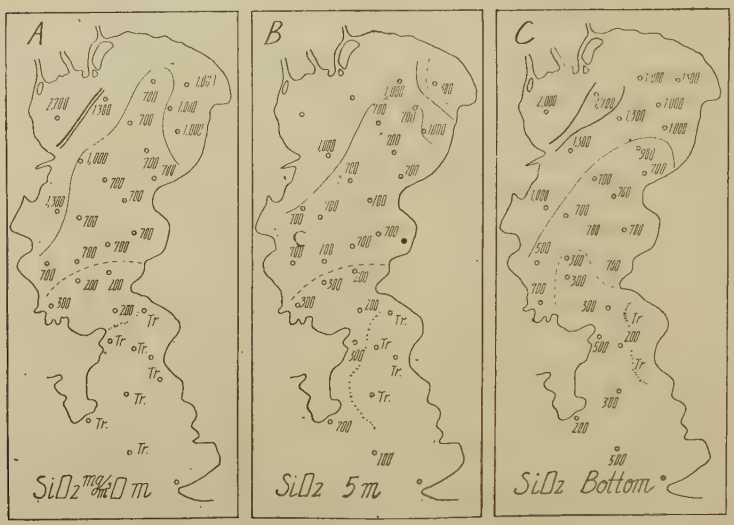

Fig. 7. Distribution of silicates (SiO_2 mg/m^3) of the superficial layer (A), of the 5 m layer (B) and of the bottom (C) during July 4–9, 1948. *Tr.* indicates trace.

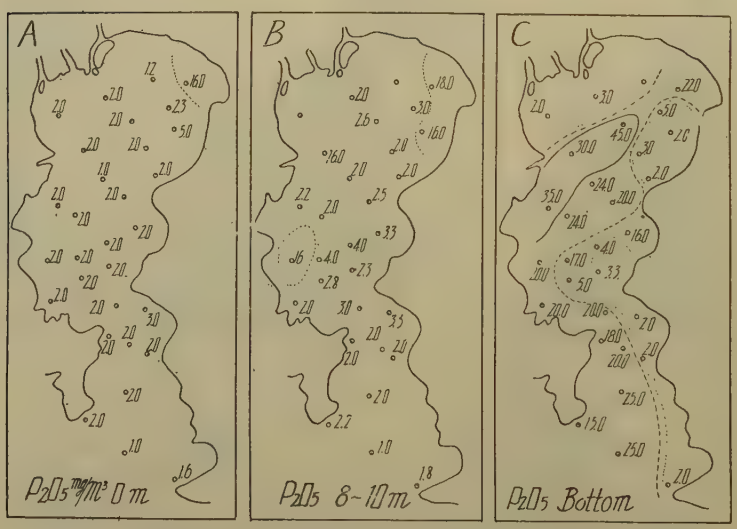

Fig. 8. Distribution of phosphates (P_2O_5 mg/m^3) of the surface layer (A), of the 5 m layer (B) and of the bottom (C) during July 4–9, 1948.

Plankton

A. Quantitative Analysis of Plankton

The settling volume of plankton at the stations in the bay was relatively large, being between 0.1 and 1.0 cc per one meter haul (Fig. 9, A). It was the smallest in the outer region where the volume was less than 0.5 cc. It was also very small in the innermost area, measuring from 0.2 to 0.5 cc per one meter haul. The highest volume was found in the eastern half of the central region, from 0.7 to 1.0 cc.

The same tendency was shown in the case of the total number of plankton. It was also very large throughout the stations, being from 70 to 1,550 thousands per one

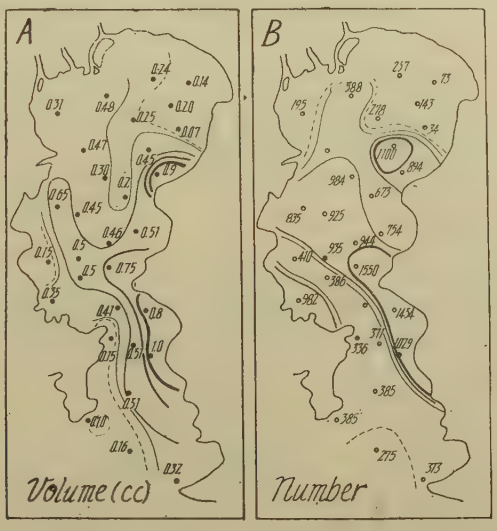

Fig. 9. Settling volume (cc) of plankton per one meter haul from the bottom or 50 meters to the surface (A) and total number of plankton of individuals, cells or colonies per one meter haul. Unit of number is thousand.

meter haul (Fig. 9, B). The largest number was about 1,550 thousands near the eastern coast of the central region and two predominant patches of more than 1,000 thousands were found. The smallest was in the innermost area of the inner region and the outer region of the bay, mostly less than 200 thousands. The poor area extended from east to west along the estuaries at the head and further southwards along the western coast.

There are considerable differences between the inner, central and outer region in both the volume and total number. The settling volume and total number are generally parallel in the inner region, while in the central and outer regions they are not in close accordance to each other (Fig. 10, A). The volume declined at stations where

the number was very large, as will be shown later on, because of the richness of diatoms.

As shown in Fig. 11, A, the distribution of zooplankton population was very sporadic in abundance. The quantity was generally very large throughout the stations in the bay. The densest population was found near the eastern coast where two centers showing more than 15 thousands were found. In the innermost region it was

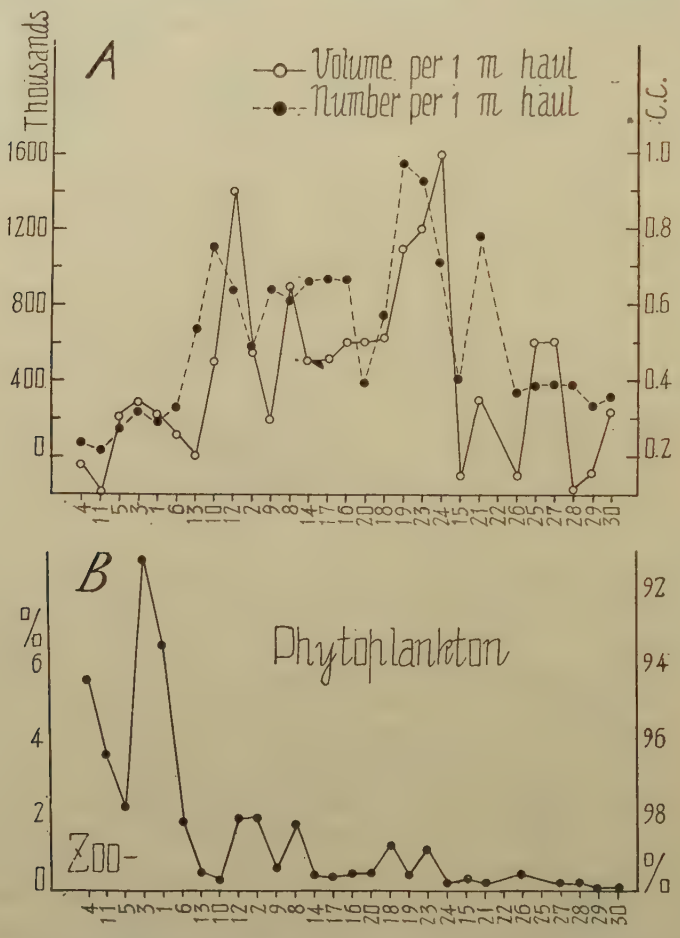

Fig. 10. Relation between settling volume and total number of plankton (A) and percentage composition between zoo- and phytoplankton (B).

also more numerous on the west than on the east. The density of phytoplankton population was almost the same as that of zooplankton population. Both populations were relatively poor near estuaries at the head and in the entrance of the bay. These distributional figures of plankton exhibit a close correlation with the hydrological conditions of the bay, as will be discussed later.

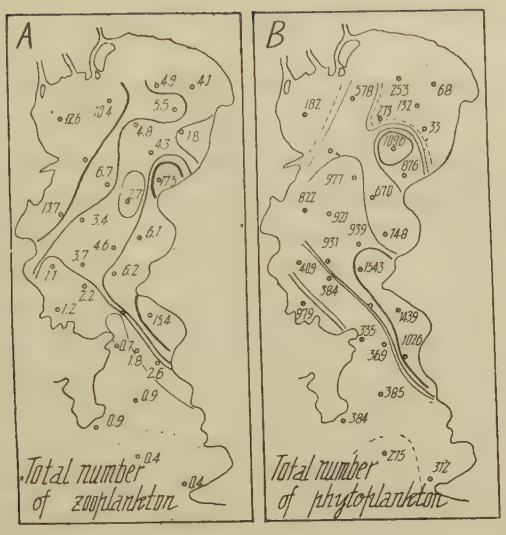

Fig. 11. Distribution of total number of zooplankton (A) and phytoplankton (B).

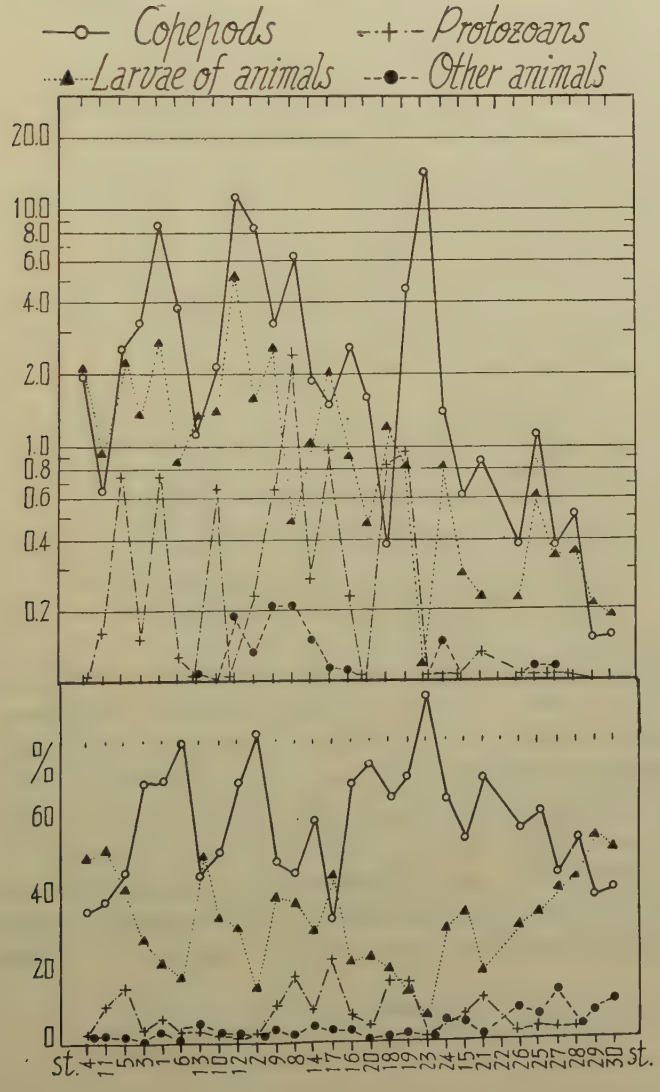

Fig. 12. Number of zooplankton groups at each station (above) and their percentage composition (below).

B. Qualitative Analysis of Plankton

ZOOPLANKTON

Copepods (40–80%), larval forms (10–50%) and protozoans (1–20%) were the important groups in the zooplankton collected in the bay. The other animals are low in percentage composition, less than 10% (Figs. 12 & 13). The number and percentage of copepods in total plankton were higher in the innermost and eastern areas of the central region, except at several stations off Tiba than in the western area of the central region. The highest percentage was obtained at the innermost station (Sts. 1 and 2) and off Huttu (St. 23) in the central region, measuring 80–90% of the total zooplankton. Figs. 14, 15 and 16 show the number and its percentage composition of important species of copepods at each station. Among them *Acartia clausi* was less than 40% of the total copepods, *Oithona nana* 30–60%, *Paracalanus parvus* 1–20%, *Microsetella norvegica* 2–6% and *Oithona similis* less than 30%.

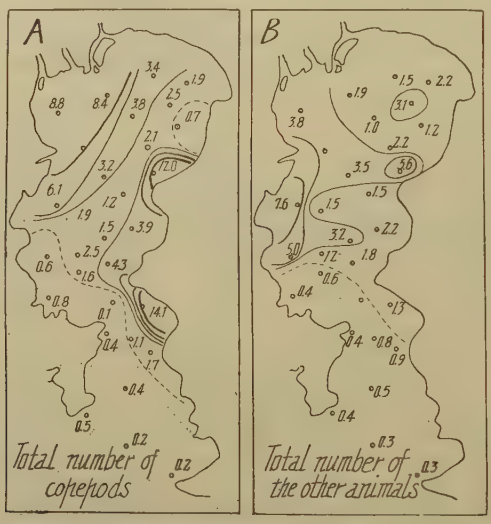

Fig. 13. Distribution of total number of copepods (A) and total number of the other animals (B).

These figures clearly indicate the centers of abundance to be very different between the species. *Acartia clausi* (Fig. 14, A) was the most abundant in the innermost area near the estuary of Edo-gawa (1,000-2,000 individuals per one meter haul; 30–40%) and steadily decreased towards the entrance of the bay (500–800 individuals; 5–20%). It was very sparsely found in the western half of the central region and in the outer region (less than 50; 3%). *A. spinicauda* was not found at all in this survey. *Oithona nana* (Fig. 14, B) was widely distributed and abundantly occurred in the northwestern corner of the inner region and on the eastern coast of the central region (500–8,000: 85–95% and 300–10,000; 40–95%, respectively). Its population

decreased from the east to the west in the central region and then towards the mouth along the western coast. *Paracalanus parvus* (Fig. 14, C) was smaller in percentage and number of individuals than the former two species. Although it was evenly distributed in the bay, the main area was the eastern half of Uraga-suido and the

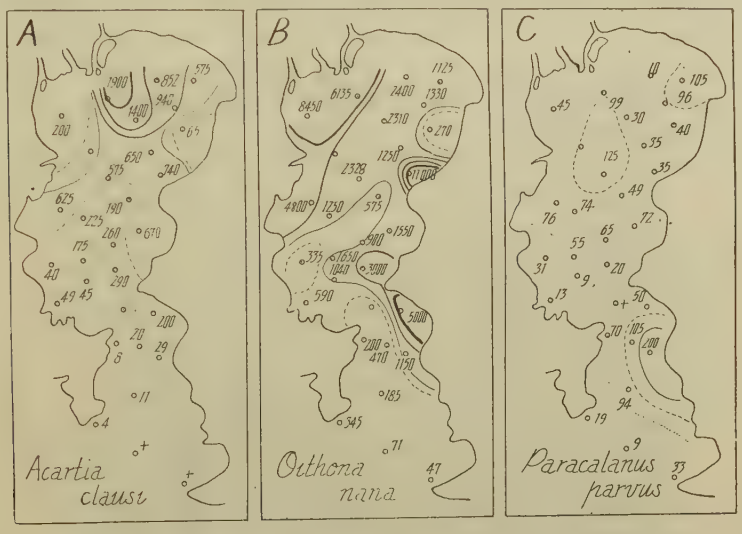

Fig. 14. Distribution of important copepods per one meter haul.

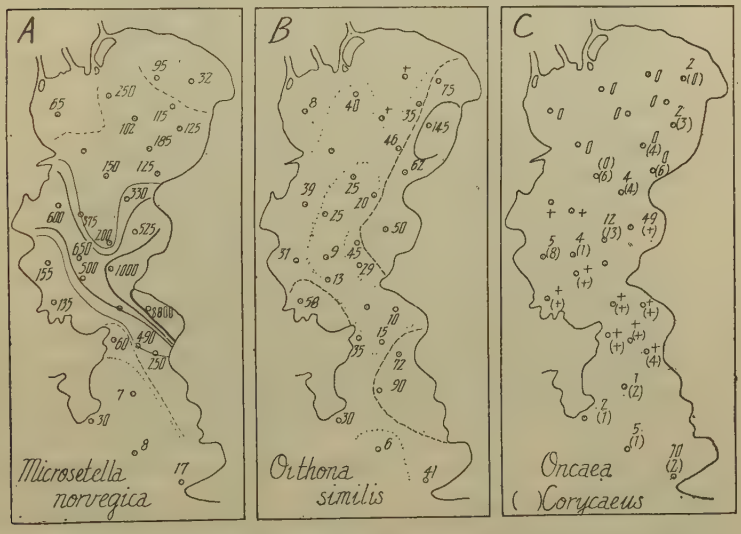

Fig. 15. Distribution of important copepods per one meter haul.

northeastern corner of the inner region off Tiba. *Microsetella norvegica* (Fig. 15, A) also showed a similar distribution to that of *Paracalanus parvus* and *Oithona nana*, but the stock was smaller than the *Oithona nana* population (20–60%; 1,000–8,000).

It decreased towards the inner region where was predominated by *Oithona* and *Acartia*; the appearance of large number of this species is very remarkable. *Oithona similis* (Fig. 15, B) was distributed widely in the bay in small numbers as was *Paracalanus parvus*, and the main dominant area was the outer region. Its percentage reached 10–25% in the mouth and less than 2% in the inner region. In the northeastern corner

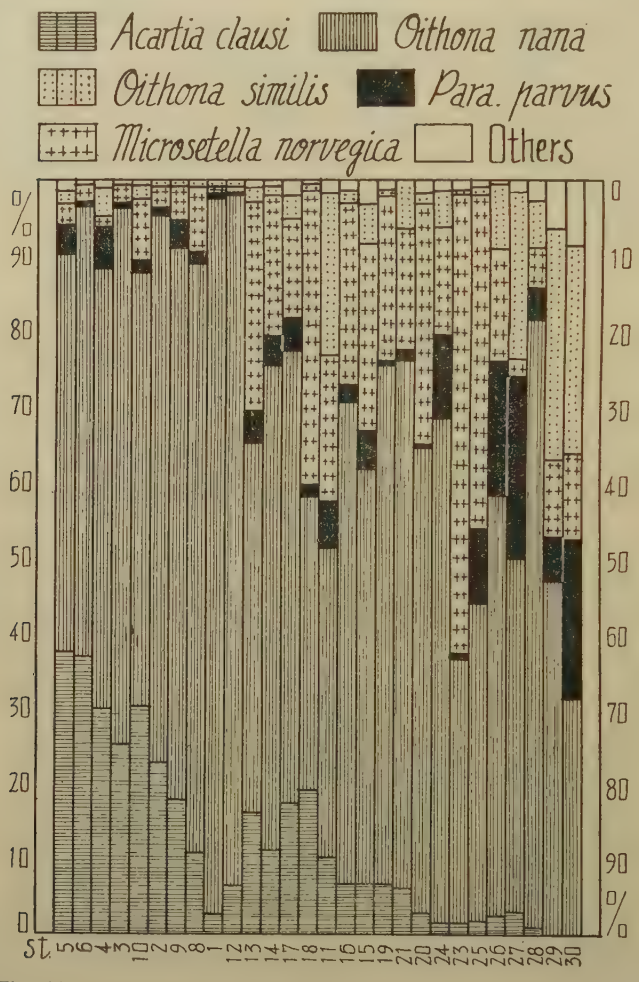

Fig. 16. Percentage composition of important copepods per one meter haul.

of the inner region a narrow patch with relatively large numbers was found, but it may be due to the inflow of more populated water masses of the outer region, judging from the distribution of other open sea forms. *Oncaea media*, *Oncaea venusta*, *Oncaea* spp. and *Corycaeus* spp. were more important in the outer region than in the inner. They occurred mainly in the mouth and along the eastern coast, but were not obtained

at all along the western coast and the innermost region. At the stations of the central and outer regions, oceanic copepods, such as *Calanus helgolandicus*, *Cal. tenuicornis*, *Cal. minor* and *Oithona plumifera* were occasionally found.

An inlet form of the tunicate *Oikopleura dioica* (Fg. 17, A) showed also a similar distribution as that of *Oithona nana*. Its distributional center was found at the northwestern corner of the inner region off Tôkyô Harbour. It was markedly poor in the outer region. *Oikopleura longicauda* (Fig. 17, A) and *Doliolum* sp. were distributed sparsely in the outer region and extended inwards along the eastern coast. Cladocerans *Evadne tergestina* and *Penilia schmackeri* were sparsely found everywhere. Several species of chaetognaths were found throughout the stations, but among them the inlet forms were abundant in the inner region.

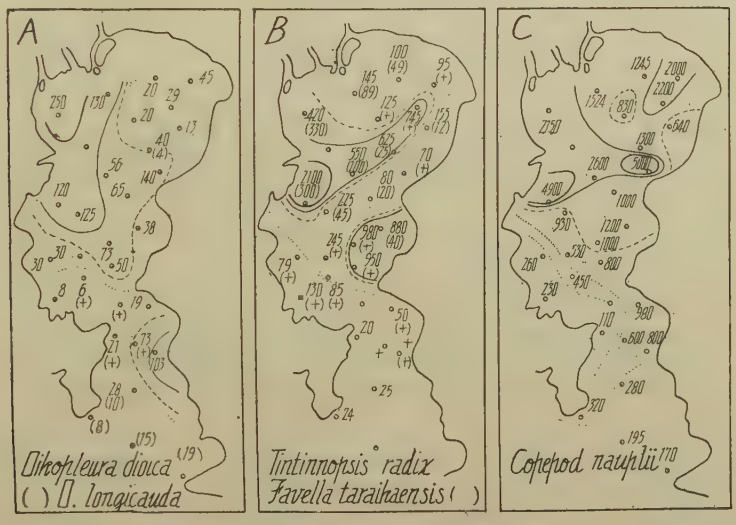

Fig. 17. Distribution of important zooplankton species or groups per one meter haul.

Among protozoans, *Tintinnopsis radix* (Fig. 17, B) was the most abundant and distributed mostly in the inner and central regions where it showed less than 2,000 individuals and decreased eastwards and southwards. Off Huttu there was found also a similar distribution, though less than 400 individuals. Its smallest populations occurred in the outer region and in the northeastern corner of the inner region. *Tintinnopsis mortenseni* occurred sparsely in the central and the outer regions.

Copepod nauplii, comprising mainly of *Oithona nana* and of small number of other forms, were widely distributed and occupied by the high percentage of the total zooplankton. Their maximum numbers were found in the inner region (1,000–5,000). From the mouth to the western half of the central region they were very scarce (1,000–3,000 individuals). Polychaete larvae and pelecypod veligers were widely distributed, though they were dominant larval forms in the central region (less than

130 and 400 respectively). Gastropod veligers, ascidian tadpols and echinoplutei were distributed towards the eastern coast of the central region, though in lesser numbers.

PHYTOPLANKTON

The distribution of some important groups and species of phytoplankton are shown in Figs. 18, 19 and 20. Of diatom groups, Pennatae was the most predomi-

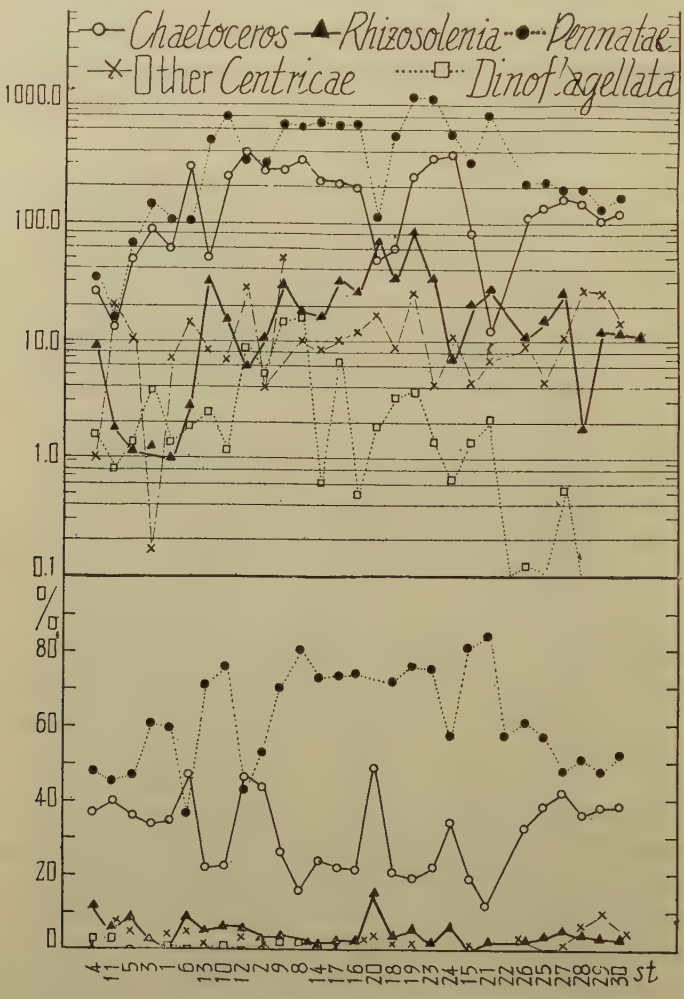

Fig. 18. Number of important phytoplankton groups per one meter haul (A) and their percentage composition (B). Unit of number is thousand.

nant group represented by 85% of total phytoplankton, and less than 1,000 thousands. They occurred abundantly in the central region and decreased towards both the inner and outer regions. *Chaetoceros* comprising many species were represented from 20

to 300 thousands and from 20 to 50%. Its distribution was the same as that of the Pennales group. Other Centricae and Dinoflagellata were very sparse in number and percentage composition.

The main species of Pennales were *Thalassiothrix Frauenfeldii*, *Thalassionema nitzschioides*, *Nitzschia seriata*, *Nitzschia longissima* and *N. sigma*. *Th. Frauenfeldii* (Fig. 20, A) was predominant in the central region and smallest in the northeastern

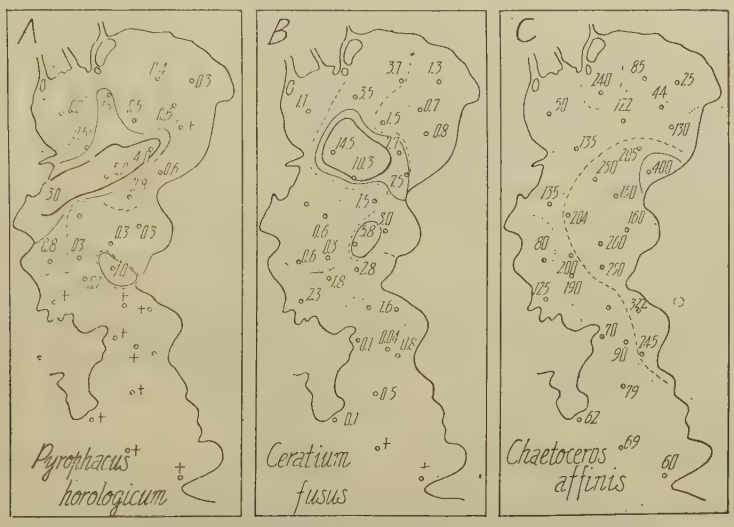

Fig. 19. Distribution of important species of phytoplankton per one meter haul. Unit of number is thousand.

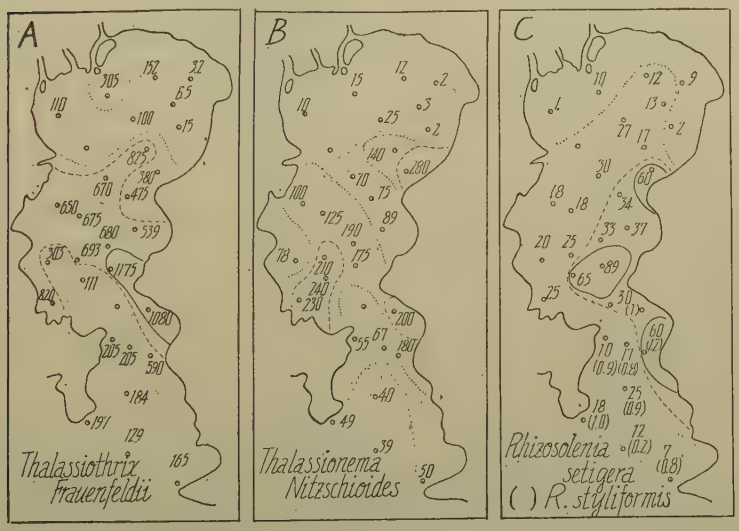

Fig. 20. Distribution of important species of phytoplankton per one meter haul. Unit of number is thousand.

corner of the inner region. *Th. nitzschioides* (Fig. 20, B) was also distributed in the same tendency, but the population was far smaller than that of *Thalassiothrix*. These populations may have been brought by the inflow of oceanic water. The other three species were very poor in number. Of *Chaetoceros*, *Ch. affinis* was the richest in the eastern part of the central region and decreased towards the entrance and the inner region. The other *Chaetoceros* were unimportant in the inner region but they were relatively abundant. They are *Ch. didymus*, *Ch. decipiens*, *Ch. Van Heurcki*, *Ch. curvisetus*, *Ch. compressus*, *Ch. Lorenzianus*, *Ch. messanensis*, *Ch. coarctatus*, etc. *Rizosolenia setigera* showed almost the same distribution as in *Ch. affinis*. *Rhizosolenia styliformis*, *Rh. calar avis*, *Rh. Stolterfothii* and *Rh. robusta* occurred in the outer region in small numbers. The Centricae such as *Skeletonema costatum*, *Guinardia flaccida*, *Biddulphia sinensis*, *Bidd. longicruris*, *Ditylum sol*, *Eucampia Zoodiacus*, *Coscinodiscus gigas*, *Cos. Granii*, *Cos. centralis*, etc.

Among dinoflagellates *Ceratium fusus* and *Pyrophacus horologicum* (Fig. 19, A, B) were relatively abundant. The former was the richest in the central area of the inner region and spread southwestwards. The latter was also found very abundantly off Yokohama and spread eastwards. The other dinoflagellates occurred at the central and mouth of the bay in small numbers. They are *Peridinium depressum*, *Per. conicum*, *Cer. furca*, *Cer. pennatum*, *Cer. macroceros*, *Cer. masciliense*, *Cer. tripos*, *Cer. trichoceros* and *Cer. molle*.

The difference in the distribution of plankton organisms indicate the influence of the hydrological and topographical conditions. The discharge from the rivers and polluted waters in the northern and western coasts of the bay as well as both the inflow and outflow of water and the circular currents seem to control the distribution of plankton. This may be explained by a comparison between the plankton communities of different regions. The populations of *Pyrophacus horologicum* and *Ceratium fusus* occurred most abundantly in the inner area northeast of Yokohama. This indicates that the two species can thrive in highly polluted and less-saline water. The diatoms occurred abundantly in the central region than in the inner region possessing rather stagnant, highly polluted and lower saline water. The concentration of diatom communities in the surface layer of the central region may suggest the mixture of different water masses which originate from the inner coastal region and from the outer open sea.

Discussion

Regional Distribution of Plankton

From preceding data and figures, the plankton communities of Tôkyô Bay may be represented by the following 5 dominant copepod species, and their mixed communities. Among the predominant copepods, *Oithona nana* occurred widely in large quantities, but the remaining 4, namely *Acartia clausi*, *Microsetella norvegica*, *Para-*

calanus parvus and *Oithona similis* are rather restricted in occurrence, so that the regional demarcation may be possible. The following distributional map is thus drawn according to the relative abundance of these associated copepods (Fig. 21, Table 1 and 2 and Plates XIX and XX).

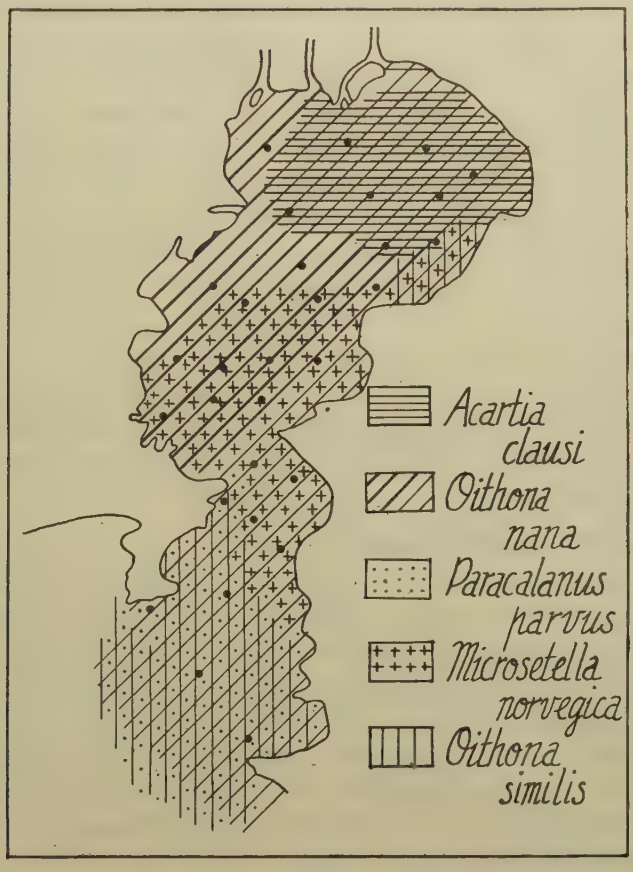

Fig. 21. Distribution of dominant copepods in Tôkyô Bay.

1. *Oithona nana—Acartia clausi* community.

In the northeastern area of the inner region the water is abundantly occupied by *Oithona nana* associated with large numbers of *Acartia clausi*, copepod nauplii and *Ceratium fusus*. Other associates are given in the first column of Table 1. The animal productivity, especially of copepods, is large, but the vegetative productivity is relatively small in such sheltered waters.

This area close to the estuaries is shallow, and its water is highly stagnant with brown color and very small transparency. The chlorinity and oxygen content are lower than in other communities. The oxygen content of the bottom layer is very small and low in percentage.

2. *Oithona nana* community.

Along the northwestern coast off Yokohama, other copepods than *Oithona nana* are very few. The largest population and percentage composition of *Oithona nana* are 8,500 and 95% of all copepods respectively. This community is characterized by the predominance of neritic tintinnids *Tintinnopsis radix* and *Favella taraikaensis*, tunicate *Oikopleura dioica*, copepod nauplii, dinoflagellates *Pyrophacus horologicum* and *Ceratium fusus*. These associated species occupied the largest population throughout the stations. *Chaetoceros affinis*, *Thalassiothrix Frauenfeldii*, *Thalassionema nitzschioides*, *Rhizosolenia setigera* and among copepods *Microsetella*, *Oithona similis* and *Paracalanus parvus* are also distributed, but they are not so common as in the other areas. According to FUJIYA (1952), *Skeletonema costatum* is most abundant in July. In my sample, however, it is very small in number, except in the innermost region. The productivity in this area is almost similar to the former community in both the zoo- and phytoplankton.

The area occupied by this community is relatively shallow, approximately 30 m in depth. The salinity, oxygen, phosphates and transparency are the lowest in the bay. The water is brown in color and much polluted by sewage from the city. The silicates are most abundant. These hydrological conditions seem to control the diatom growth and to favour some special species of plankton.

3. *Oithona nana—Microsetella norvegica* community.

The central region of the bay is occupied by large numbers of *Oithona nana* and *Microsetella norvegica*. The largest number of both copepods is 8,500 and 8,800 respectively. This community is associated with large numbers of diatoms such as *Ch. affinis*, *Thalassiothrix Frauenfeldii*, *Thalassionema nitzshioides*, *Rhizosolenia setigera*, etc. which are the most predominant in the bay. Among zooplankton associated with this, the copepods *Acartia clausi*, *Paracalanus parvus*, *Oncaea*, *Corycaeus* and a tunicate *Oikopleura dioica* are important, but these populations are smaller than in the other areas. The productivity of both zoo- and phytoplankton is greater in the eastern half than in the western half.

The western half of this area is deeper than the eastern half. The water shows higher transparency, higher chlorinity, larger contents of oxygen, lower silicates and phosphates than in the foregoing two areas.

4. *Oithona nana—Paracalanus parvus—Oithona similis* Community.

The outer region of the bay, south of Kannon-zaki, is characterized by the mixed high percentage of three or four important copepods, *Oithona nana*, *Oithona similis* and *Paracalanus parvus* (or *Microsetella norvegica* too). Of these, *Oithona nana* and *Microsetella* are far poorer than in the inner region, and many oceanic species such as *Oikopleura longicauda*, *Doliolum*, *Calanus*, *Eucalanus*, *Rhizosolenia* and *Chaetoceros* spp. are found in small numbers. The productivity of both zoo- and phytoplankton is smallest.

TABLE 1. Composition of four major copepod communities in Tôkyô Bay. (Unit of phytoplankton number is thousand and each number per one meter haul from surface to bottom or less than 50 meters)

	Oithona–Acartia community	*Oithona* community	*Oithona–Microsetella* community	*Oithona–Microsetella–Paracalanus–Oith. similis* community
Settling volume of total plankton (cc/one meter of haul)	0.2—0.48	0.3—0.65	0.2—1.0	1.0—0.5
Total number of plankton (thousand of one meter of haul)	34—1,100	195—980	400—1,150	300—388
Total number of zooplankton	4,100—10,500	6,700—13,700	1,100—15,400	400—2,600
Total number of phytoplankton (thousand of one meter of haul)	33—1,096	180—980	400—1,550	300—385
Zooplankton				
Acartia clausi	600—1,900	200—700	20—740	< 11
Oithona nana	1,125—6,139	1,200—8,450	330—11,000	47—480
Paracalanus parvus	10—100	30—120	75	9—94
Microsetella norvegica	32—250	60—600	125—8,800	7—17
Oithona similis	< 75	8—40	9—62	6—41
Oncaea media	< 2	0	< 50	< 10
Corycaeus spp.	< 2	0	< 15	< 2
Copepod nauplii	60—2,000	2,100—3,000	230—5,000	110—280
Tintinnopsis radix	90—275	400—2,100	50—1,000	< 25
Favella taraikaensis	< 100	100—300	< 100	0
Oikopleura dioica	20—130	30—250	8—140	< 21
Oikopleura longicauda	0	0	< 1	< 19
Phytoplankton				
Pyrophacus horologicum	0.3—1.3	0.2—3.0	0—0.8	a little
Ceratium fusus	0.7—14.5	1.1—10.3	0.3—5.8	0.1
Chaetoceros affinis	25—240	50—130	80—400	60—70
Thalassionema nitzschioides	2—25	10—100	70—240	40—55
Thalassiothrix Frauenfeldii	15—305	100—820	111—1,175	130—200
Rhizosolenia setigera	2—27	1—30	20—89	7—25
Rhizosolenia styliformis	0	0	1—1.2	0.2—0.9

TABLE 2. Hydrological conditions in four major copepod communities in Tôkyô Bay.

	Oithona–Acartia community			*Oithona* community			*Oithona–Microsetella* community			*Oithona–Microsetella–Paracalanus–Oith. similis* community		
Depth (m)	<20			<30			<20 (eastern) 20–60 (western half)			100–700		
Transparency (m)	2.5–4.0			2.1–3.6			2.0–5.0			8–10		
Water color (No.)	Brown			Brown			7–8			4–5		
	0 m	5 m	bottom	0 m	5 m	bottom	0 m	5 m	bottom	0 m	5 m	bottom
Temperature (°C)	18–20	—	16.5–21	20–22	—	16–19	21–23	—	15.8–17	20–21.8	—	7–17.0
Chlorinity (‰)	16–18.1	—	17.5–18.5	10–15.7	—	15–17.5	15–17.5	17.5–18	17.5–18.8	17.7–18.3	18.4–18.6	18.8–19.0
Oxygen (cc/l)	4.6–6.08	5.1–5.2	2.1–3.8	5–6.6	3.8–5.5	4.0–5.3	6.1–7.1	5.0–6.0	4.1–6.5	5.4–6.8	5.4–5.7	4.3–5.0
" (%)	82–113	—	37–67	86–122	—	70–79	113–133	—	70–117	103–128	—	73–75
SiO_2 (mg/m³)	700–1,000	300–700	100–1,700	700–2,700	—	700–2,000	<700	<700	300–700	Tr	100–300	300–500
P_2O_5 (mg/m³)	2	2–5	3–5	2	2	2–3.5	2–3	3–5	5–20	1–2	1–3	3–25

As Tôkyô Bay is a secondary inlet extended from Sagami Bay, the plankton community near the mouth shows a more embaymental characteristics than in the bays of Kamaisi (YAMAZI, 1954) and Miyako (YAMAZI, 1954) where are strongly influenced by the open sea water. Diatoms and zooplankton peculiar to inlet waters occur very abundantly in the inner region north of Kannon-zaki.

Current System as Inferred from Plankton Distribution

The plankton is generally at the mercy of the hydrological factors especially horizontally, since it must move with the water. The variation in the distributional area of the abundance of the plankton and of the number of species suggests the movement of the water masses. The use of plankton as indicators of the coastal water movements has been discussed by many workers (SØMME, 1933, 1934; REDFIELD and BEALE, 1940; REDFIELD, 1941; RUSSELL, 1935; 1936; FRASER, 1952; WIBORG, 1954). A preceding paper dealing with the plankton of Miyazu Bay (YAMAZI, 1955) showed that the inlet plankton community which are distributed regionally can be used as indicators of water masses and their circulation in the bay or inlet. We may consequently examine the nature of the water circulation of the bay or inlet to see if it can account for the fluctuations in number of species and population density in different places, and to learn to what extent the regional plankton community may be carried into and out the bay or inlet by water movement, although a pronounced diurnal or vertical migration needs to be fully discussed.

The inlet or bay waters surrounding Japan in Kurosio region are characterized by the predominance of the following species: *Acartia clausi* (from winter to summer), *Acartia spinicauda* (from summer to autumn), *Oithona nana*, *Favella taraikaensis*, *Tintinnopsis radix*, *Sagitta delicata*, *Sagitta crassa* (in winter), *Sagitta crassa* f. *naikaiensis* (in summer and autumn), *Oikopleura dioica* and a diatom *Skeletonema costatum*. These species can be used as indicators of inlet or estuarine waters. In Tôkyô Bay *Acartia clausi*, *Oithona nana*, *Oikopleura dioica*, *Sagitta crassa* f. *naikaiensis*, *Skeletonema costatum* spread along the western coast from the innermost area and extend further out of the bay in small numbers. A part extends eastwards off Haneda and Yokohama where *Acartia* occurs abundantly. In the northeastern corner upwelling of underwater runs westwards, and then mixes with *Acartia*-water near estuaries.

Microsetella community which dominates the central region of the bay extends from the eastern area of the inner region towards the north and southwards along the eastern coast. The small specimens of this copepods occur widely in the whole area, but are very scanty in the outer region southwards from Kannon-zaki where the inflowing current is strong. The water of this area contains abundant diatoms such as *Thalassiothrix Frauenfeldii*, *Thalassionema nitzschioides* and *Nitzschia seriata*, and copepods such as *Oithona similis* and *Oncaea* spp. *Chaetoceros* spp. are also important.

The above fact seems to indicate that the inner region of the bay is clearly demarcated from the outer region topographically, but the plankton communities of the inner region consist of a mixture of inner and outer origins.

The water of the outer region is characterized by the predominance of offshore

Fig. 22. Current system in Tôkyô Bay deduced from the distribution of plankton communities.
-----→ In-coming open sea water, ——→ Circulating, partly out-going inlet water.

forms comprising *Oikopleura longicauda, Fritillaria haplostoma, Oncaea, Corycaeus,* several calanoids, oceanic diatoms and dinoflagellates. They are practically abundant out of the bay. They extend to the eastern area of the inner region, and a small patch is found in the central area where they are associated with the inlet forms.

The populations of these immigrants of offshore origin are very small in number and wholly absent in the northwest corner of the inner region.

The water masses as indicated by the distribution of plankton communities are in good agreement with the general features of the circulation observed by drift-bottle method and current measurements in the surface or 10 m layers (KOBE MARINE OBSERVATORY, 1931). Summarizing the results of plankton investigations stated above, I give here a synthetic current chart of Tôkyô Bay, though in-coming open sea water be could noted treat minutely as shown in Fig. 22. Especially the complex nature of the water movements off Yokosuka to Huttu-saki and off Haneda and Yokohama can be understood from the components of plankton communities there. It will be necessary to treat the life history and the age length on each species definitely in future. A distributional study of the size frequency in growth stages of these inlet copepods will also give us many informations in regard to the origin of the stock and supply our present knowledge on the water masses and their movements.

Summary

1. The regional quantitative distribution of plankton in Tôkyô Bay during the summer of 1948 is discussed.

2. The bay is characterized by the predominance of copepod *Oithona nana* throughout the area. In percentage composition of the total copepods, however, three faciations, all accompanied by *Oithona nana*, are recognized, that is (1) *Oithona nana* and *Acartia clausi* community, associated with *Oikopleura dioica*, *Sagitta crassa* f. *naikaiensis* and *Skeletonema costatum* in the innermost region, (2) *Microsetella norvegica* and *Oithona nana* community in the central region, (3) *Paracalanus parvus*, *Oithona nana* and *Oithona similis* community, associated with *Corycaeus* spp, *Oncaea* spp. and calanoids in the entrance or outer region.

3. The ecological conditions of zoo- and phytoplankton are discussed on the basis of the previous hydrological data.

4. The variation in the center of abundance of plankton communities is closely correlated with the surface circulation, deduced from the hydrological observations. The water movement of this bay is thus clearly interpreted from the regional distribution of plankton community.

5. It is shown that the planktonic indicators for inlet or bay waters are *Acartia clausi* (from winter to early summer), *Oithona nana*, *Acartia spinicauda* (from summer to autumn), *Microsetella norvegica*, *Oikopleura dioica*, *Sagitta crassa* f. *naikaiensis* (from summer to autumn), *Sagitta crassa* (from winter to spring), *Saggita delicata*, *Tintinnopsis radix*, *Favella taraikaensis*, diatoms *Skeletonema costatum*, *Thalassionema*, *Thalassiothrix* and *Nitzschia*. *Oithona similis*, *Oncaea media*, *Oncaea venusta*, *Corycaeus*, calanoid copepods, *Oikopleura longicauda*, *Fritillaria* spp., *Sagitta enflata*, doliolids, etc. are regarded as indicators of open sea water or outer region of bay.

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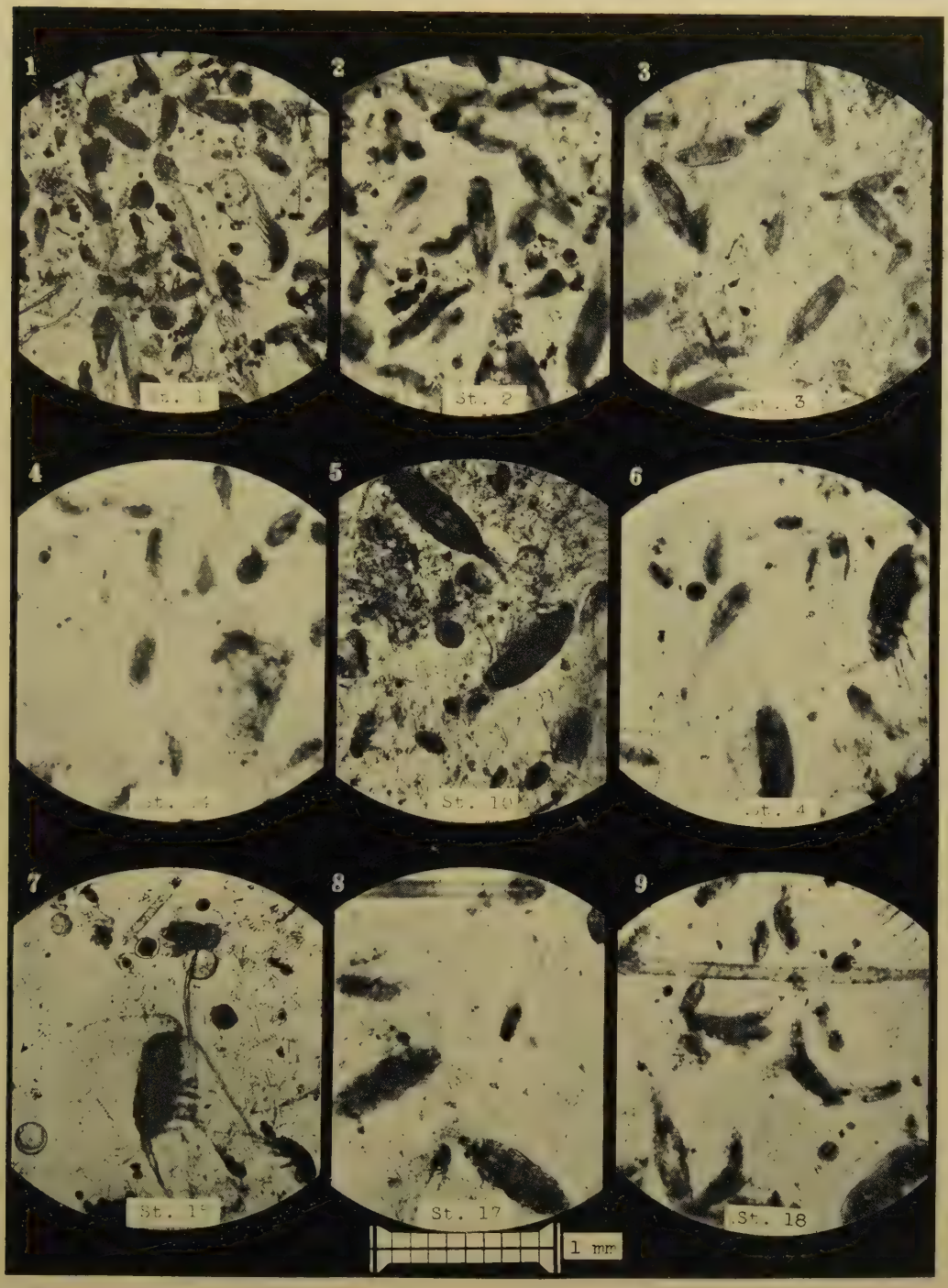
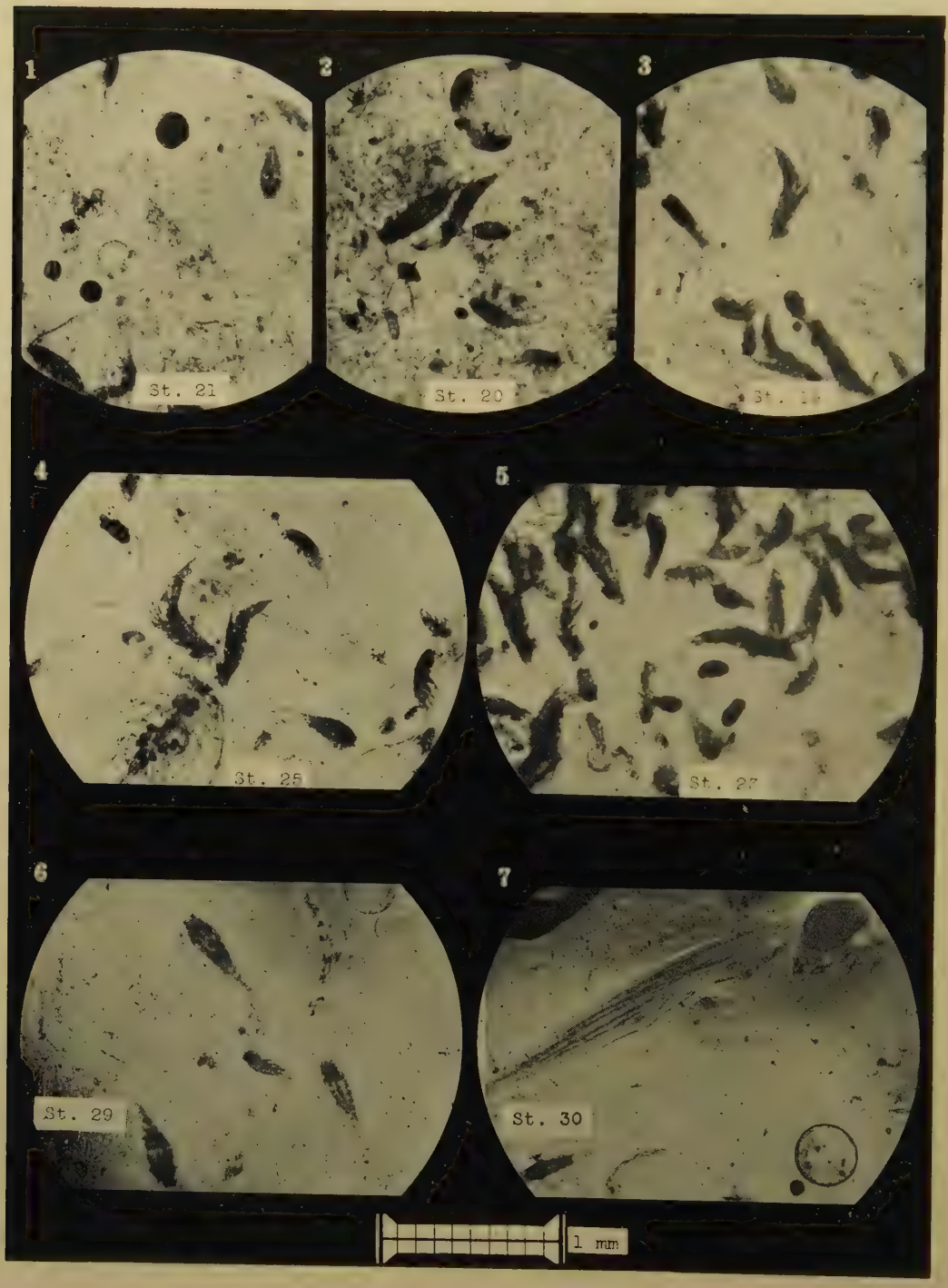


I. YAMAZI: PLANKTON INVESTIGATION IN INLET WATERS, XVI.



I. Yamazi: Plankton Investigation in Inlet Waters, XVI.

EXPLANATION OF PLATES XIX–XX

Plate XIX

Fig. 1. *Oithona nana* community, associated with *Sagitta crassa* f. *naikaiensis*, and pelecypod veliger (Station 1).

Fig. 2. *Oithona nana–Acartia clausi* community associated with the same species of figure 1 (Station 2).

Fig. 3. The same community, associated with copepod nauplii, *Microsetella norvegica* and diatoms (Station 3).

Fig. 4. *Oithona nana* community, associated with copepod nauplii, *Tintinnopsis radix* and diatoms (Station 14).

Fig. 5. *Oithona nana—Acartia clausi* community, associated with copepod nauplii, pelecypod veliger, *Tintinnopsis radix* and diatoms (Station 10).

Fig. 6. The same community, associated with copepod nauplii, *Oithona similis*, pelecypod veliger and diatoms (Station 4).

Fig. 7. *Oithona nana—Microsetella norvegica* community, associated with *Oikopleura dioica, Tintinnopsis radix* and diatoms (Station 15).

Fig. 8. *Oithona nana—Microsetella norvegica* community, associated with *Paracalanus parvus, Sagitta crassa* f. *naikaiensis* and diatoms (Station 17).

Fig. 9. The same community, associated with *Acartia clausi, Paracalanus parvus*, pelecypod veliger, *Sagitta crassa* f. *naikaiensis, Tintinnopsis radix* and diatoms (Station 18).

Plate XX

Fig. 1. *Oithona nana—Microsetella norvegica* community, associated with pelecypod veliger, copepod nauplii and diatoms (Station 21).

Fig. 2. The same community, associated with copepod nauplii, *Peridinium* and diatoms (Station 20).

Fig. 3. The same community, associated with diatoms (Station 19).

Fig. 4. The same community, associated with *Penilia schmackeri, Oikopleura dioica*, copepod nauplii and diatoms (Station 25).

Fig. 5. *Microsetella norvegica—Oithona nana* community, associated with pelecypod veliger, copepod nauplii and diatoms (Station 23).

Fig. 6. *Oithona nana—Paracalanus parvus—Oithona similis* community, associated with copepod nauplii and *Coscinodiscus* (Station 29).

Fig. 7. The same community, associated with *Oikopleura longicauda, Oikopleura dioica, Coscinodiscus* and diatoms (Station 30).

PLANKTON INVESTIGATION IN INLET WATERS ALONG THE COAST OF JAPAN

XVII. SEASONAL SUCCESSION OF ZOOPLANKTON IN THE INNER AREA OF TANABE BAY FROM JUNE TO OCTOBER, 1954[1)]

Isamu YAMAZI
Seto Marine Biological Laboratory, Sirahama

With 9 Text-figures

This paper deals mainly with the seasonal variation in the quantitative and qualitative distribution of zooplankton in the innermost area of Tanabe Bay during the period from June to the end of October, 1954. The plankton and water samples were collected off the coast of Tunasirazu where is located at the southern inlet in Tanabe Bay every other day or occasionally every three days. The towing was made vertically from the bottom (5 m in depth) to the surface with a Kitahara's quantitative silk tow net. After macroplankton such as larger medusae were removed, the total volume and number of other plankton organisms were measured separately. The volume of the samples was measured by the settling method. The counting was made to obtain percentage composition and estimated the individual number of various species per one meter haul. Although there were no sufficient data about the occurrence of microplankton, the 200 cc of water sample was taken in every towing.

In connection with this survey in Tanabe Bay, a routine observation on zoo- and phytoplankton in Taizi Bay and the Moriura inlet of Katuura Bay during the same period (Yamazi and Horibata, 1955) has been made simultaneously by Mr. Horibata as a co-worker and this survey is now still in progress. The present report may be of some interest in view of the fact that (1) the plankton samples were obtained every other day and at the same time the hydrological and meteorological data of the environment were available for comparison. (2) During the same period, a similar observation was made in two different bays, Tanabe and Katuura Bay, both situated on the opposite side of Kii Peninsula. By analyzing and separating these data it may be possible to deduce the influence of environmental factors on the plankton communities.

This work was aided by a grant from Scientific and Technical Research Expenditures of the Ministry of Education, administered by Prof. T. Matsudaira of

1) Contributions from the Seto Marine Biological Laboratory, No. 262.

Tôhoku University, to whom my sincere thanks are due. And also I am indebted to Mr. S. URA and Miss Y. MORI of our Laboratory for the aid of field work and meteorological observations in the course of this work.

Brief Summary on Periodical Changes from Summer to Autumn

June 1st–20th: Surface water temperature gradually rose from 20°C to 24°C (Fig. 1). There was considerable fluctuation in the chlorinity from 17 to 18‰, due to a small rainfall and drainage (Fig. 2). Phosphate values (P_2O_5) were relatively small, being about 10 mg per m^3. Silicate contents (SiO_2) varied between 900–1,500 mg per m^3. The catalytic activity of sea water was relatively high but showed an irregularity (Fig. 3). During the early days total plankton volume and total zooplankton number were very small, but became gradually larger (Fig. 4).

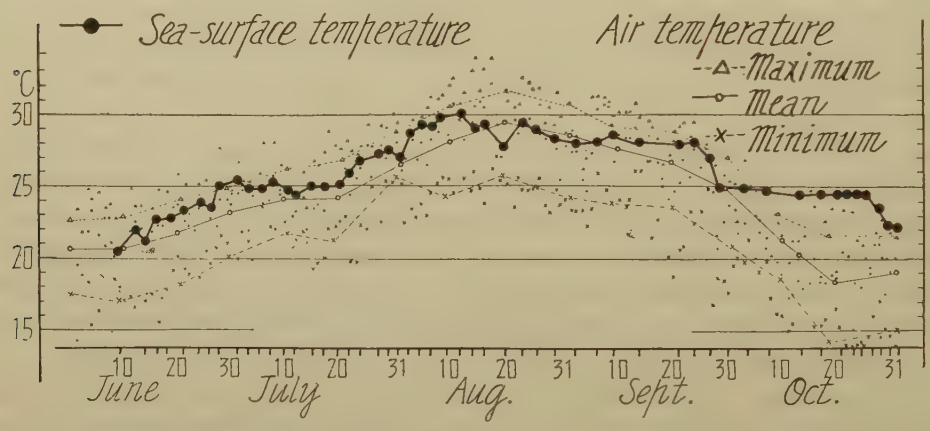


Fig. 1. Seasonal changes in air and sea-surface temperature in Tanabe Bay from June to October inclusive, 1954.

June 21st–30th: The water temperature slightly rose from 23°C to 25°C, but the chlorinity suddenly fell to 13‰ because of a heavy rainfall. Silicate contents showed a sharp rise from 1,000 to 2,000 mg per m^3. Catalytic activity of sea water and phosphate contents showed a smaller fall respectively. The total plankton volume considerably increased, though zooplankton numbers increased slightly.

July 1st–10th: The chlorinity suddenly increased from 13‰ to more than 17‰. Phosphate and silicate contents as well as catalytic activity of sea water showed a gradual fall. The total plankton volume was relatively small but zooplankton number prominently decreased except for one case when the number was very small.

July 11th–20th: The number of total plankton was relatively the same as in the early decade, but a gradual increase was found later. The number of zooplankton reached the maximum throughout the whole summer period. The temperature was

almost the same as in the early decade. The chlorinity showed more than 17‰, and the phosphate and silicate contents were small. The catalytic activity of sea water was quite irregular.

July 21st–31st: The volume of total plankton, especially of *Chaetoceros*, then increased to a maximum abundance throughout the whole period and then actually decreased at the end of July. The number of zooplankton was uniformly rich with 2–3 thousands per one m haul. The phosphate reduced from 7 to 9 mg per m^3 and silicate gradually fell. The chlorinity gradually increased and reached from 17 to

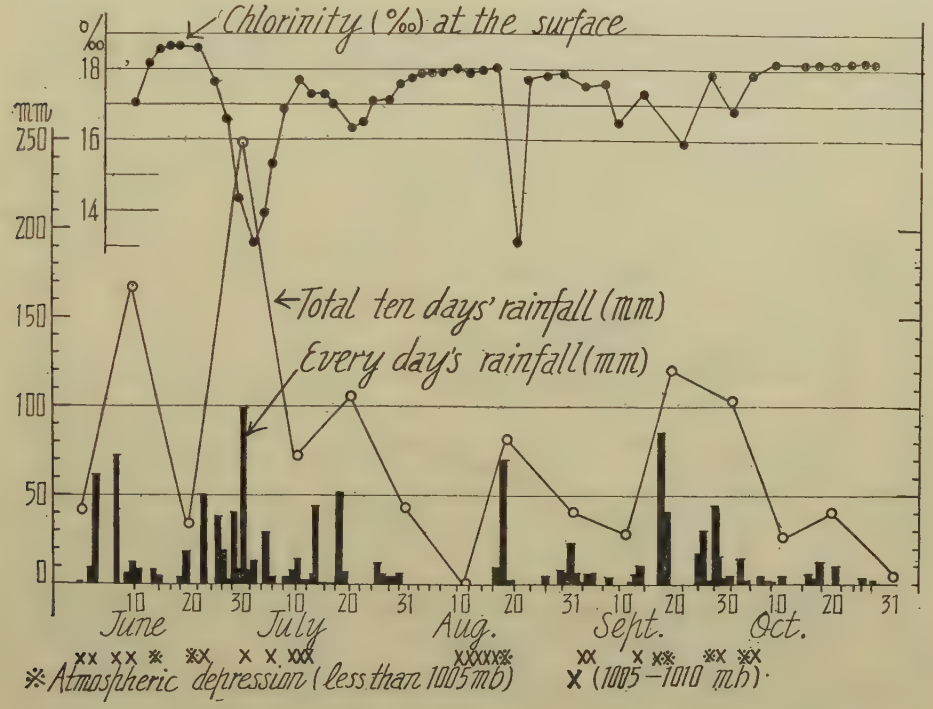


Fig. 2. Variations of surface chlorinity (above), total ten days' and every day's rainfall (middle) and main atmospheric depression (below) from June to October, 1954.

18‰. A considerable fluctuation in the catalytic activity of sea water was observed at the surface layer, varying from 5 to 30 $K_{30°C} \cdot 10^3$ as before.

August 1st–20th: The volume of total plankton gradually fell and was very scarce till August 10–20th, when there was a minimum of 0.02 cc per one m haul. Diatoms were negligible in relative abundance. The astonishing fall occurred also in both Taizi Bay (Yamazi and Horibata, 1955) and Uranouti (Ueda, 1949), suggesting that it is not a local phenomenon. The temperature reached its maximum 30°C for the year on August 10th, and thereafter began to fall gradually. The

chlorinity was uniformly higher (18‰) except only on August 21st (13‰), when a typhoon (No. 12) came across. Low values were observed for the phosphate contents (5–10 mg per m^3), the silicate contents (1,000–1,500 mg per m^3) and the catalytic activity of sea water (10–20 $K_{30°C} \cdot 10^3$).

August 21st–September 30th: During the last decade of August to the beginning of September there was a very small increase in the volume of total plankton and the number of zooplankton, but not in the middle decade of September. But in the

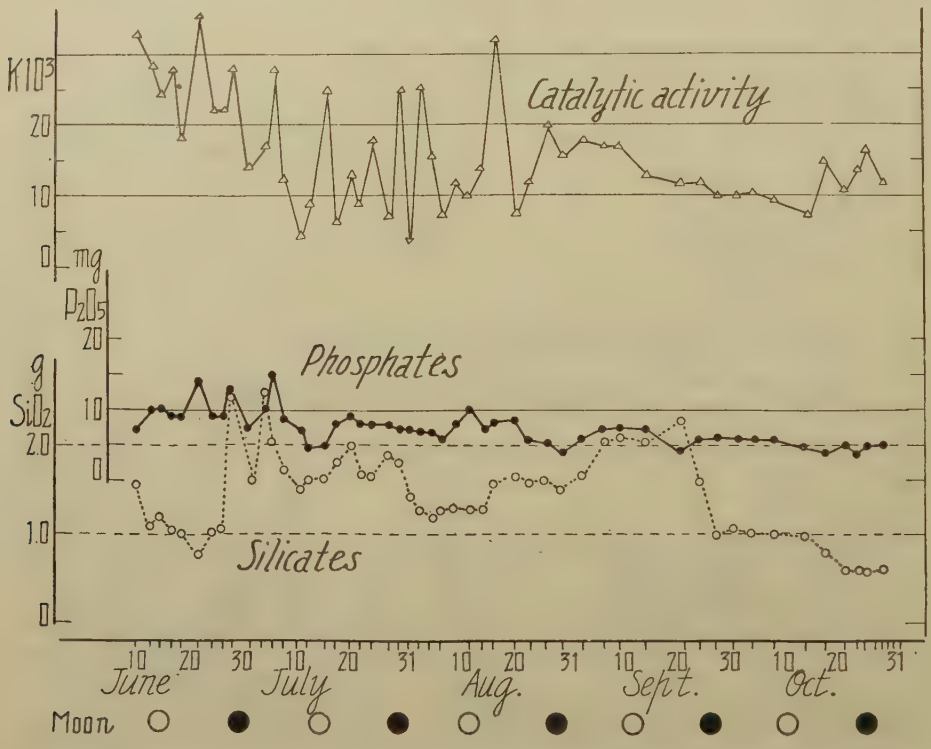


Fig. 3. Variations of catalytic activity of surface water ($K_{30°C} \cdot 10^3$) (above), phosphates (P_2O_5, mg/m^3) (middle), silicates (SiO_2, mg/m^3) (below) at the innermost station of Tanabe Bay and the age of the moon during the period from June to October, 1954.

last decade of September the volume and number gradually increased. The water temperature decreased slightly from 29°C to 27°C and fell sharply from September 30th when it was about 25°C. These were considerable fluctuations in the chlorinity from 10 to 18‰, becoming gradually lower, and also a small fall in phosphate contents and a rise in silicate contents.

The data given above show that the quantity of plankton is closely correlated with the hydrological conditions in early summer. The plankton volume decreases with the fall of the chlorinity, when the latter is considerably influenced by rainfall.

This may be due to the decrease of diatoms or to the sinking down to the bottom from the hauled layers. On the other hand the population of zooplankton was continually increasing in number coincided with low salinity and a gradual fall of temperature. In the highest temperature and salinity as in the late summer, both zoo- and phytoplankton were not abundant. Occasionally a great variation in volume

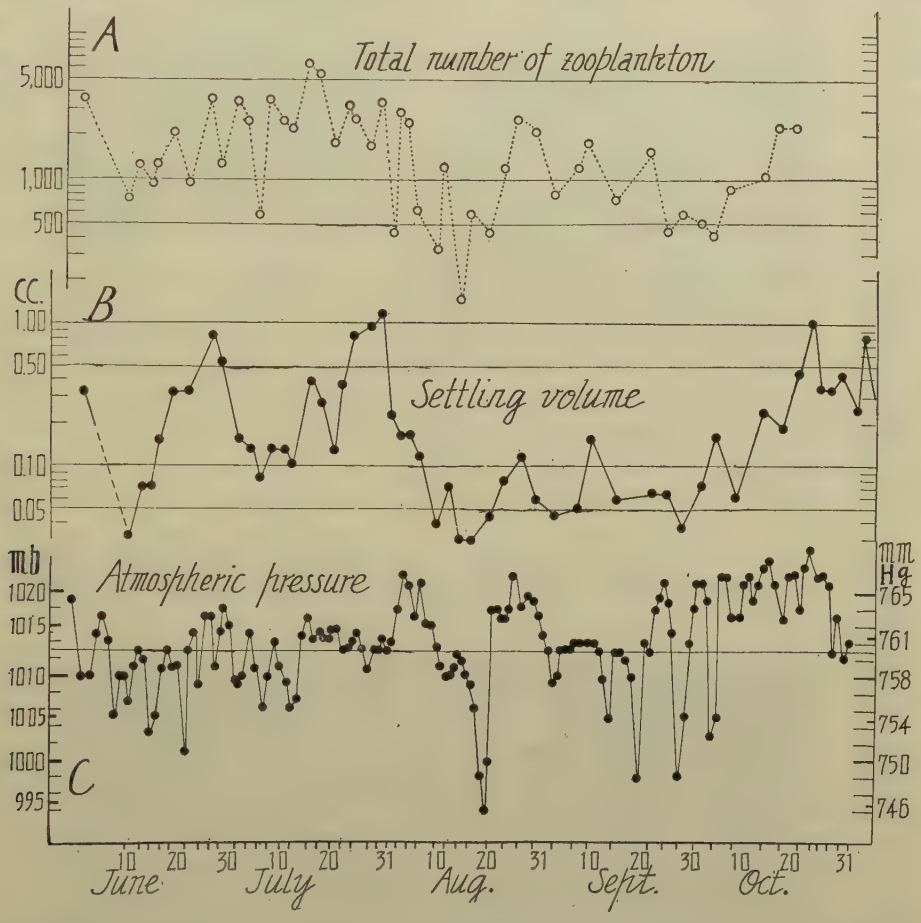


Fig. 4. Variations of total number of zooplankton per one meter haul (A), settling volume (B) and every day's atmospheric pressure during the period from June to October, 1954.

of total plankton and in number of zooplankton occurred at intervals of a few days, these figures being obtained in routine observations. The hydrological conditions, especially water movement caused by atmospheric pressure, wind and tide may be of great importance, as the plankton samples showed the differences in composition of the species.

Seasonal Variations of Zooplankton

The abundance of zooplankton is rather irregular in this inner region of the bay as in other bays. The plankton occurs in swarms or in different water masses. The most important zooplankton in the inner area of Tanabe Bay is as usual copepods (Fig. 5), followed by the larval forms. Protozoans and the other animals are not important in number. Copepods were most numerous, but showed relatively large fluctuations. On the whole they were not abundant in early June and gradually increased, and attained the maximum at the end of July. Although almost disappeared

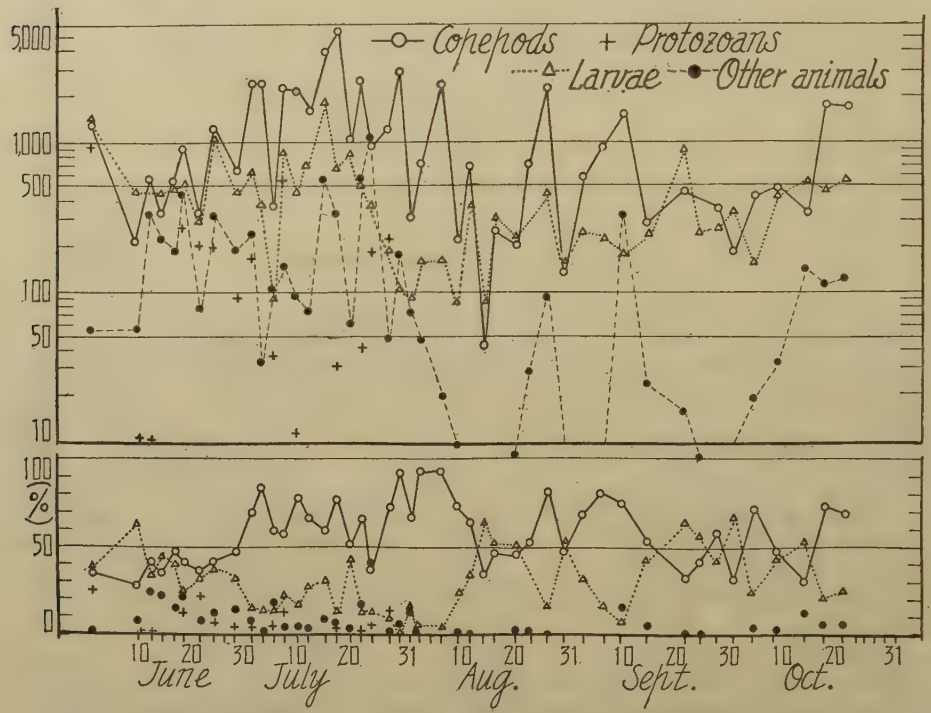


Fig. 5. Variations of total number of zooplankton per one meter haul (above) and their percentage composition (below).

there in the middle of August, they gradually increased during the end of August to September. The larval forms and other animals showed a considerable fluctuation in occurrence, but were mostly abundant during early June to the end of July. In August and September they were not encountered or very scarce.

All the copepods such as *Oithona nana*, *Paracalanus parvus*, *Acartia clausi*, *Acartia spinicauda*, *Oithona similis*, *Oncaea media*, *Microsetella rosea*, *Microsetella norvegica*, *Oithona rigida*, *Centropages* sp., *Oncaea venusta* and *Corycaeus* sp. occurred there as important components. The seasonal change of these copepods in number and percentage composition is given graphically in Figs. 6 and 7. As shown in the

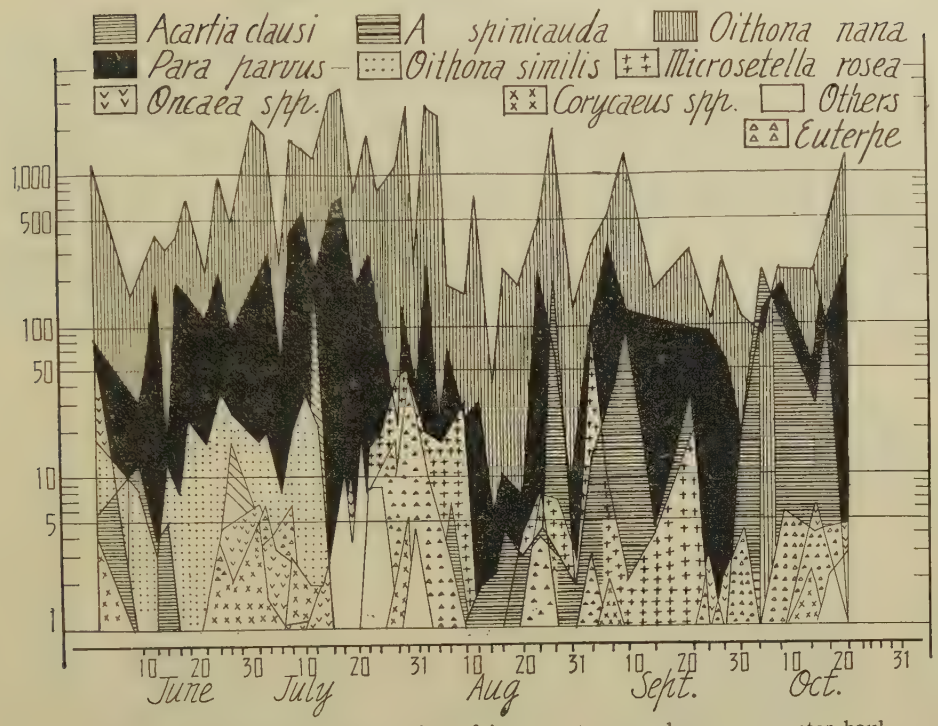


Fig. 6. Variations of total number of important copepods per one meter haul.

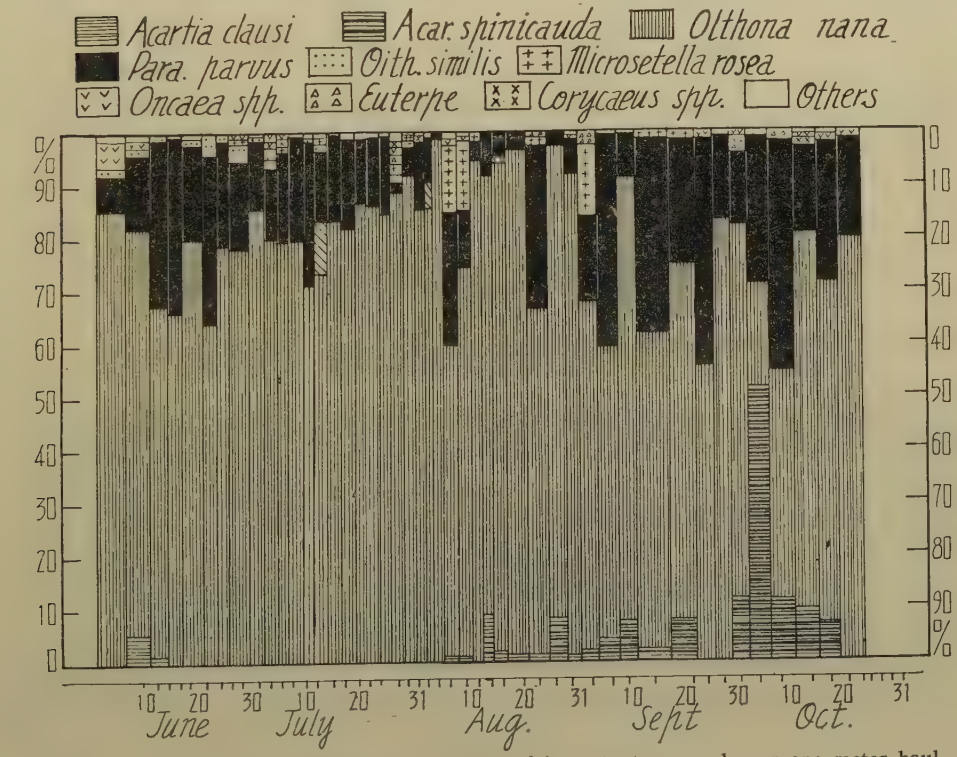


Fig. 7. Variations of percentage composition of important copepods per one meter haul.

two figures, the most abundant copepod was *Oithona nana* though the number was rather irregular. Generally it was very common in early summer but relatively less abundant in late summer and in early autumn. Its percentage reached 60–90% of the total copepods throughout this period except for two cases in autumn. *Paracalanus parvus* which was a subdominant copepod, occurred in the same manner of flactuation as in *Oithona nana*. Its percentage was from 5 to 45% of the total copepods. *Acartia clausi* was very small in number and percentage composition in this period. It did not appear after the end of June. On the other hand, *Acartia spinicauda* at first appeared scarcely after the beginning of August and became commoner till the

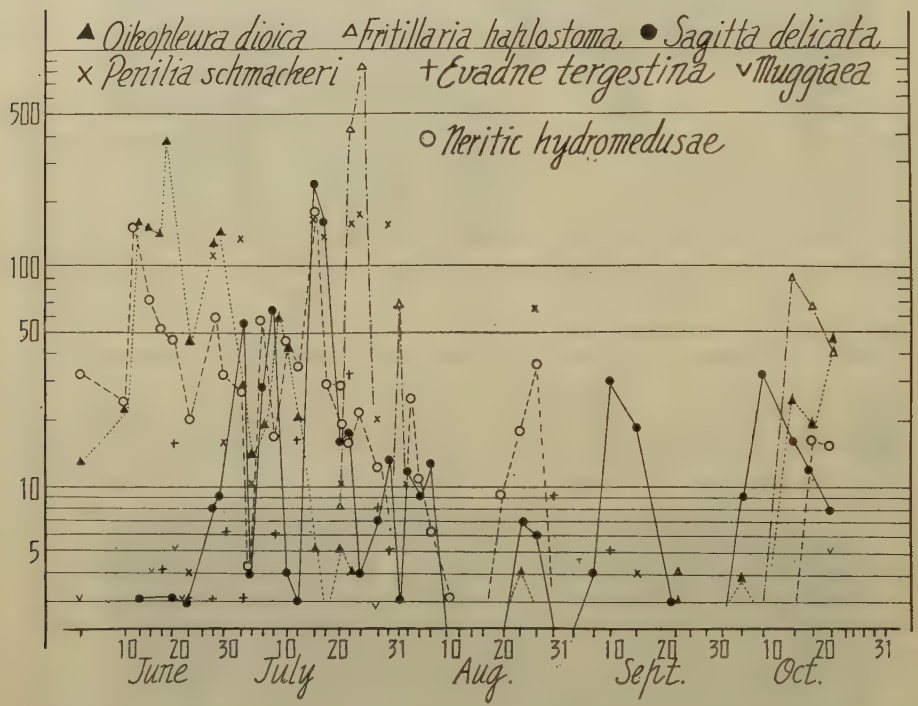


Fig. 8. Variations of total number of important zooplankton per one meter haul.

end of October. *Oithona similis* occurred till the middle of July but so far disappeared. *Microsetella rosea* was found during August and September. *Oncaea* appeared from the end of July to the end of October. These two species were only in very small numbers. Several individuals of *Oithona rigida* were found only at the end of June.

The Cladocera such as *Penilia schmackeri* and *Evadne tergestina* also appeared in swarms, the former being common in July and in early September (Fig. 8). After the end of September it disappeared. The chaetognath *Sagitta delicata* (Fig. 8) appeared always in large numbers in early summer. After the end of August three peaks were found, although their number was smaller than in July. Among tunicates,

Oikopleura dioica was the commonest. It occurred abundantly in early summer and after midsummer. The oceanic tunicate *Fritillaria haplostoma*, on the other hand, occurred in swarms in the middle of July, even when *Oikopleura dioika* scarcely appeared. In midsummer the inlet forms such as *Oikopleura dioica*, larval forms were very small in number, while the oceanic forms such as *Fritillaria*, *Muggiaea*, copepods and chaetognaths were relatively rich. This suggests that the influx of oceanic water is stronger than in the other period. These oceanic forms appeared in small numbers in late summer and autumn, but later disappeared suddenly.

Although the various benthic animals have different breeding period, their larvae

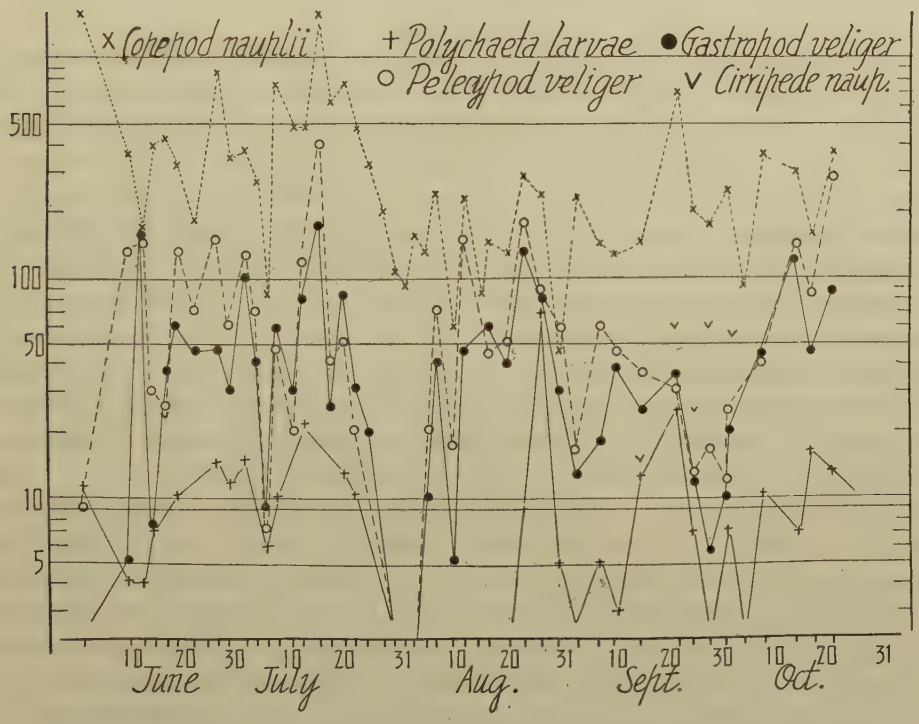


Fig. 9. Variations of abundance of important larval forms per one meter haul.

are numerous in early summer (Fig. 9). The larval plankton was represented mainly by copepod nauplii, larvae of polychaetes, veligers of pelecypods and gastropods and cirripede nauplii. The proper identification of most larval forms was very difficult except for some species of copepods and a few benthic animals. Copepod nauplii were always found in greater numbers than the other larval forms, with two peaks in July and September. They were more abundant in early summer than in autumn, and decreased in midsummer. Cirripede nauplii were also found in June and September, but were most abundant during the last decade of September. Polychaete larvae occurred throughout the period, except in midsummer. They were most

abundant in July and September. Both pelecypod and gastropod veligers were found with three major peaks in the middle of July, the end of August and the beginning of October. Besides, a number of different larval forms were found but it was unable to me to identify them with certainty.

The phytoplankton was most plentiful from June to July, with a maximum number in the middle of the period. Large numbers were also found in late October. An analysis of the seasonal change of phytoplankton will be discussed later in another paper.

Discussion

In the innermost area of Tanabe Bay, zooplankton community was characterized by the predominance of an inlet form *Oithona nana* and its associates during the period from June to october, 1954. The main associates are inlet forms *Paracalanus parvus*, *Penilia schmackeri*, *Evadne tergestina*, *Acartia spinicauda*, *Sagitta delicata*, *Oikopleura dioica*, larvae of benthic animals, and so on. However, a small periodical variation occasionally occurred. When the population of local plankton was poor, the open sea forms were relatively plentiful. During this period, the chlorinity at the surface showed a wide range from 13‰ to 18.7‰. At the end of June the chlorinity showed suddenly a considerable fall and rise, but after the middle of July it has been recovered to keep a mean value of 18‰ till the end of October, though a slight fluctuation occurred in September. These fluctuations of chlorinity have been reflected by the abundance of plankton population, although it cannot be explained if the chlorinity influenced directly upon the abundance of plankton or not.

During the days of low atmospheric pressure and strong southerly wind the neritic and oceanic forms such as *Oithona similis*, *Microsetella rosea*, *Oncaea* spp., *Corycaeus* spp., *Euterpe acutifrons*, *Fritillaria* sp., *Sagitta enflata*, etc. were generally found in larger numbers and the population of plankton was poorer than in other days. Although in the slight stabilization for waters from June to July the maximum of plankton was found, the late summer minimum from the late of August to the early of September which was a minimum in stabilization, and prevented rich development of plankton. This fact suggests that the open sea water deeply penetrated into this area. It is thus concluded that a strong inflow of open sea water penetrated into the innermost area of the bay having a wide mouth occasionally disturbs the abundance of inlet plankton communities localizing there.

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PLANKTON INVESTIGATION IN INLET WATERS ALONG THE COAST OF JAPAN

XVIII. SEASONAL SUCCESSION OF PLANKTON IN TAIZI BAY IN THE YEARS 1951–1953[1)]

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and
Taira HORIBATA
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With Plates XXI–XXII and 12 Text-figures

With the object of studying the stability and the seasonal succession of plankton in inlet waters, the routine works have been started since July, 1951 and are now going on in bays of Taizi, Moriura and Tanabe along Kii Peninsula. In these works our special attention was paid to the following points: (1) How the plankton communities differ regionally from the innermost part of the inlet to the open sea being influenced by topographical and hydrographical conditions, (2) the relation between the predominance of oceanic or neritic plankton and the movements of water masses, and (3) the correlation between the fishery and the hydrological environment, of which the physical and chemical factors were referred to together with the plankton as the synthetic indicator. The last point has a concern in the fishery of yellowtail *Seriola quinqueradiata* Temminck et Schlegel (Japanese name "Buri"), one of the highly appreciated food fishes in our country, which are captured by kiddle net on the fishing ground near the entrance of Taizi Bay in the season from December to May; and this fishery seems certainly to be influenced by hydrological condition of the coastal waters.

There are many works reporting the seasonal succession of plankton in inlets and bays along the coast of Japan (Kokubo, 1930–1952; Kokubo and Tamura, 1934 and 1938) Matsudaira, 1939; Ueda, 1949; Fujiya, 1952; Okitsu, 1953; Shimomura, 1953; Kado, 1954). They are, however, chiefly dealing with only the phytoplankton in detail. Moreover the plankton occurring along the Kii Peninsula is left nearly unstudied, excepting a few works by Miyadi (1940) dealing with the benthic community of the bay. Here the results of the works in Taizi Bay are described.

1) Contributions from the Seto Marine Biological Laboratory, No. 263.

Plankton and water samples were collected monthly from July, 1951 to June, 1953 at the stations indicated in Fig. 1, besides one station at the innermost area was added since April, 1952. For the meteorological data quoted in this article we are indebted wholly to the Sionomisaki Meteorological Observatory. Plankton samples

Fig. 1. Map of Taizi and Katuura Bay, showing the stations and bathymetric contours.

were hauled vertically from the bottom to the surface at each station in the daytime by KITAHARA's quantitative tow net stretched with No. 13 MÜLLER gauze. The size of the net is 22.5 cm in diameter of the mouth and 100 cm in length; therefore the mouth of the net cut off a water column of 50 liters at each one meter haul. All data and figures about the plankton imply the volume or number per one meter haul.

Samples were settled for 24 hours in a measuring cylinder and volumes were recorded in cc.

Before going further, we express here our sincere thanks to Mr. K. Oka, the director of the Sionomisaki Meteorological Observatory and to Mr. K. Ogura, a member of the same Observatory, for their kindness in allowing to use the meteorological data obtained by the Observatory.

Environmental Conditions

Of the hydrological and meteorological conditions, temperature, chlorinity, transparency, phosphates, silicates, catalytic activity of sea water, temperature, wind direction, rainfall and sunshine in the atmosphere are here concerned.

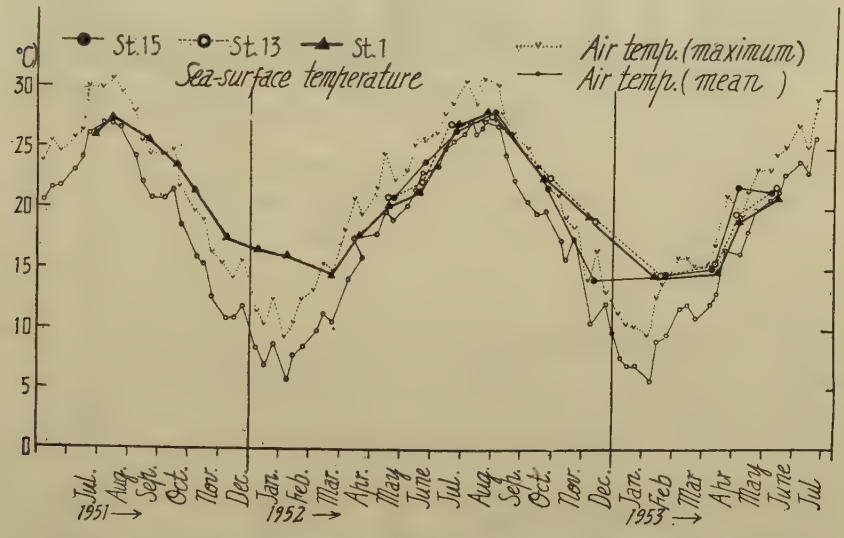


Fig. 2. Variations of the air and sea-surface temperature in Taizi Bay during the period from July, 1951 to July, 1953.
The plotted points represent 10-day averages.

Temperature (Fig. 2): Surface water temperature observed monthly and air temperature in ten-day averages and the maximum value for ten days are plotted in Fig. 2. The maximum of surface water temperature occurred during the period from late August to early September, while the minimum in February or March, and these are generally in accordance with the extremes of the air temperature. As shown clearly in the figure, the surface water temperature is generally higher than the average air temperature and the difference between the water and air temperatures is markedly large during the cold season from late autumn to early spring, while during the warmer season from early spring to autumn it is very small. The rapid

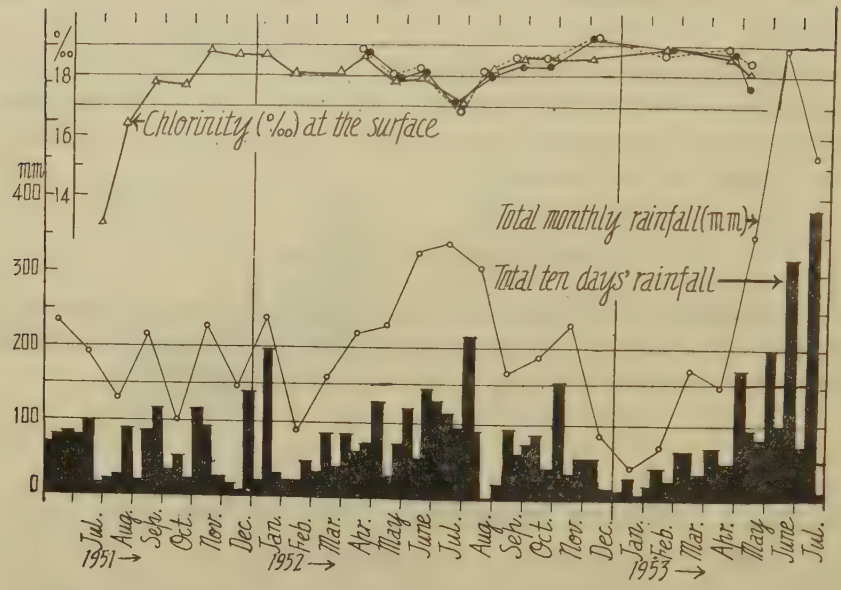


Fig. 3. Variations of the surface chlorinity (above), total monthly rainfall (middle) and total ten-days' rainfall at Siono-misaki from July, 1951 to July, 1953.

Fig. 4. Variations of the total monthly sunshine (in hour) (above), total ten days' sunshine at Siono-misaki (middle) and transparency of the sea water in Taizi Bay (below) from July, 1951 to July, 1953.

fall of the air temperature in autumn induces the gradual cooling of the surface water. The temperature at three stations situated respectively at different parts of the bay somewhat differs one another, namely the temperature in the inner region is higher during the warm season and lower during the cold season than in the outer region of the bay. This phenomenon is correlated distinctly with the stagnation of the water. During the present observations the diatom increase in winter was found in the lowest water temperature and the summer diatom maximum occurred before the temperature reached the climax.

Chlorinity (Fig. 3): The chlorinity of the surface water shows the range of variation from 17 to 19‰ throughout the year, except in early summer when it may show extraordinarily low values. The highest value is found in the coldest season from autumn to winter, while the lowest value in early summer as mentioned above. The seasonal fluctuation of chlorinity corresponds well with that of the rainfall as shown

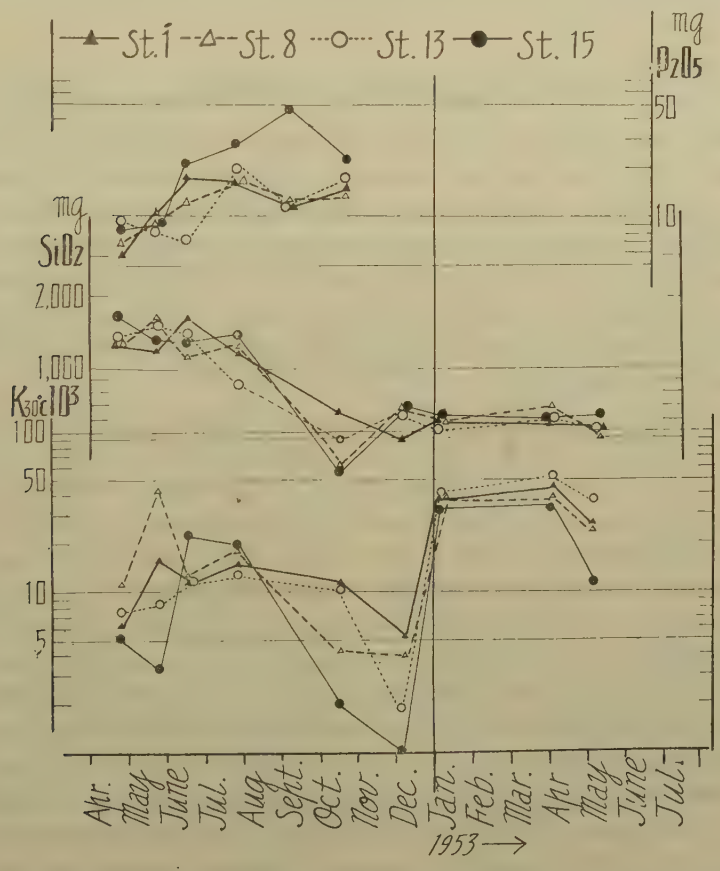


Fig. 5. The seasonal variations of the hydrological conditions in Taizi Bay. Phosphates (P_2O_5, mg/m³) (above), silicates SiO_2, mg/m³) (middle), and catalytic activity of sea water ($K_{30°C} \cdot 10^3$) (below).

in Fig. 3. The summer maximum of diatoms is accompanied by the decrease of chlorinity, which is brought by rich land drainage containing an amount of nutrient salts, although the winter propagation seems entirely not to depend upon the decrease of chlorinity.

Transparency (Fig. 4): The transparency ranged seasonally between 2 and 20 meters. The water is less transparent in the inner region than in the outer region, chiefly because of the existence of suspending debris. It was generally larger in the later half of 1951 and the early half of 1952 than in other periods. In the outer region, the lowest reading 6 m was found in the spring of 1951, while the higher readings more than 12 m were observed in late autumn in 1951 and 1952, and in the winter of 1952. These higher values may be accepted as a sign of richer inflow of oceanic water mass in these periods than in others.

Other enviromental factors are shown in Figs. 4 and 5, and the correlation between the hydrological condition and the plankton will be discussed later on.

Volume and Number of Plankton

Four stations (Sts. 1, 8, 13 and 15) were selected as representatives of the inner and outer parts of the bay and two intermediate regions between them, when we treated the data stationally. Volume and number of plankton varied seasonally and regionally, although the fluctuations seem to belong to a regular cyclic one at least in years of our observations. We found two maxima of each volume and number in a year; one was in winter and the other was in summer (Figs. 6 and 7) as in cases observed by Ueda (1949) in Uranouti Bay of Kôti Prefecture and by Kado (1954) near Mukaizima in the Inland Sea.

During July and August, 1951, the quantity of plankton and the number of species were very large, and the volume and number reached the maximum. This was induced by rich population of a few species of *Chaetoceros*, *Bacteriastrum* and zooplankton, chiefly copepods and their nauplii. The enormous abundance of typical oceanic plankton in this year is probably due to the strong inflow of "Kurosio". A small peak occurred in early November; this was induced chiefly by local flourishing of Pennatae diatoms: *Thalassiothrix*, *Thalassionema* and *Nitzschia*. This autumnal flourishing of diatoms was not found in the next year, 1952. From December, 1951 to February, 1952 and in January, 1953, the volume of plankton and the number of species declined, but soon followed by the vernal flourishing of some neritic diatoms. The vernal propagation in 1953 consisted of neritic diatoms of boreal temperate water and abundant tintinnids being associated with some neritic zooplankton of warm water and continued from January till the end of April relatively larger than in 1952; in 1952 the quantity of plankton reached the minimum during the period from the end of April to nearly the end of May. The increase of the number of warm water species began in early summer and the association changed gradually to the summer phase.

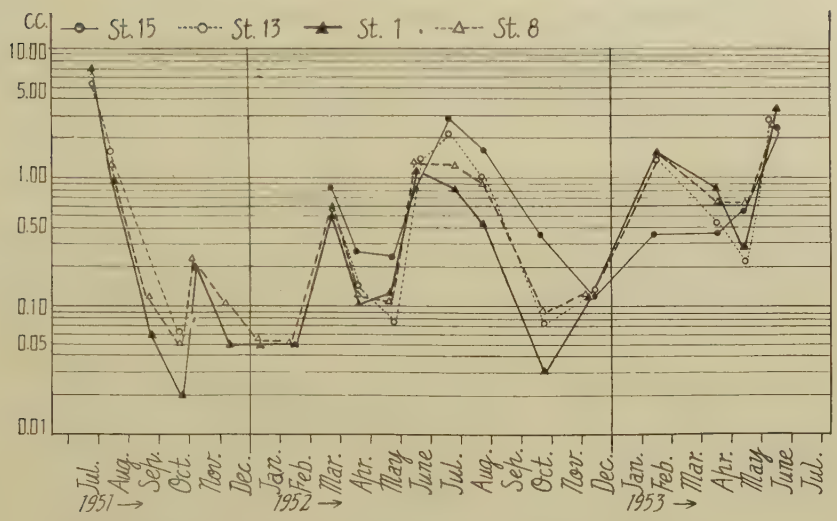


Fig. 6. Settling volume at the four stations of Taizi Bay during the period of July, 1951 to July, 1953. Unit of volume is cubic millimeter of plankton per one meter haul.

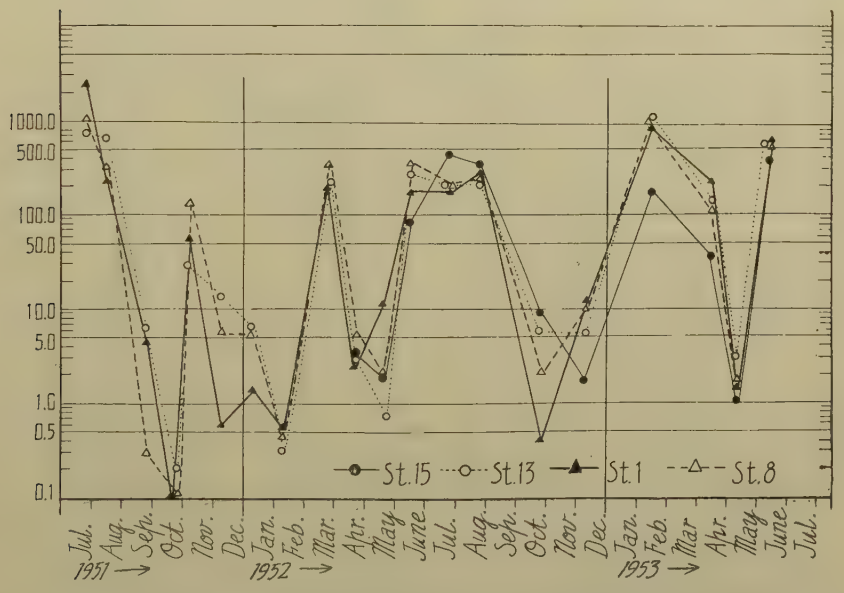


Fig. 7. The total number of plankton from the inner to the outer region of the bay per one meter haul. Unit of number is thousand.

As mentioned above, the differences in the time of occurrence of maxima of volume and number of plankton may be attributable partly to the difference of

stations; the rich population was found generally at stations in the inner part of the bay more frequently than at those in the outer part, although the richest catch throughout the whole period of our observations was recorded in the outer part of the bay in 1953.

Proportion of Zooplankton to Phytoplankton

The total quantities and the percentages of zoo- and phytoplankton varies seasonally and stationally as shown in Fig. 8. Phytoplankton shows two distinct peaks, one

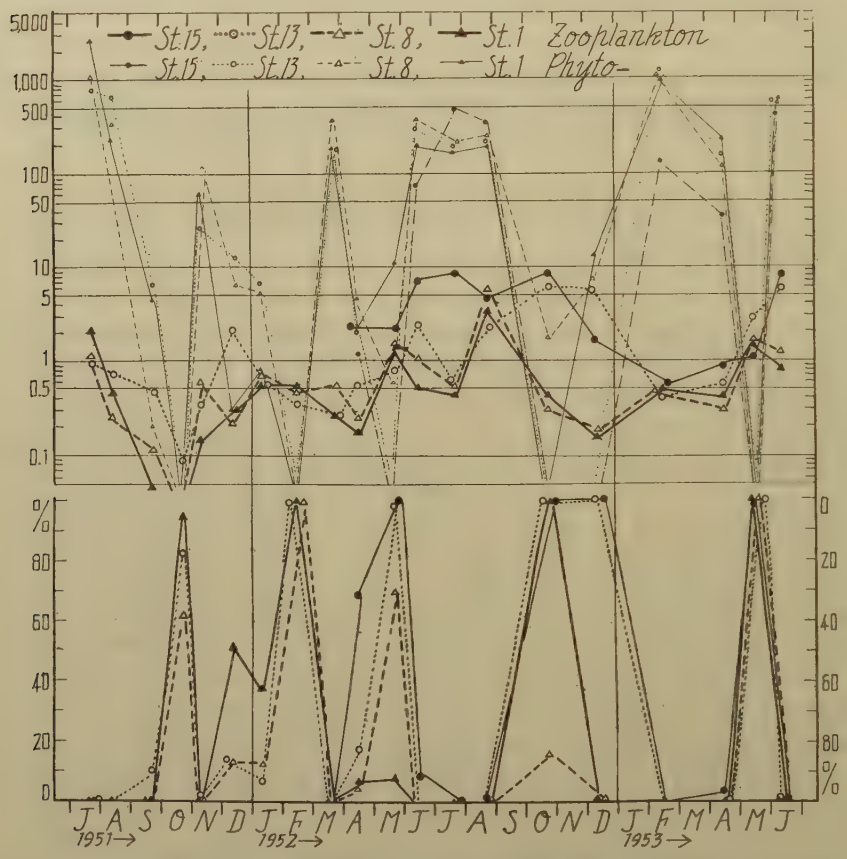


Fig. 8. Seasonal variations of the total number of zoo- and phytoplankton per one meter haul, and their percentage composition.

from late winter to early spring and the other in summer, and a temporary and indistinct one in autumn as seen in 1952, while zooplankton population is generally occupied by some special organisms.

Qualitative Succession of Plankton

Although the components of plankton in this bay is very complicated, ecologically and economically important ones in inlet waters may be summarized as follows (Fig. 9):

(1) Copepod population: *Oithona nana, Acartia clausi, Acartia spinicauda, Paracalanus parvus, Oithona similis* and *Oithona rigida* were the important species.

(2) Larval forms, including copepod nauplii, gastropod and pelecypod veligers, polychaete larvae, pluteus, besides the sporadic appearance of larvae of other benthic animals.

(3) Protozoans, including a large number of *Tintinnopsis radix, Favella taraikaensis, Poroecus apiculatus* and radiolarians.

(4) Other animals, consisting of neritic and oceanic forms excepting the preceding groups. *Sagitta delicata, Oikopleura dioica, Penilia schmackeri, Evadne tergestina* and hydromedusae of neritic waters and *Sagitta enflata, Oikopleura longicauda, Fritillaria,* and *Doliolum* of oceanic waters were the important forms.

(5) Phytoplankton including diatoms, both neritic and oceanic, and dinoflagellates. Of diatoms *Chaetoceros, Thalassiothrix, Thalassionema, Nitzschia, Bacteriastrum* and *Rhizosolenia* occurred most numerously.

Figs. 9–12 show the seasonal succession of important zoo- and phytoplankton groups or species in number and percentage.

From July to August in 1951: The plankton was composed of rich local stock and a small number of open sea species. The copepods were represented dominantly by *Paracalanus parvus, Oithona similis, Oithona nana,* and partly by a small number of *Acartia spinicauda, Microsetella rosea,* and *Oncaea media.* A large number of larval forms, consisting of abundant copepod nauplii, a considerable number of cirripedian nauplii and pelecypod veligers, were also observed. *Tintinnopsis radix* occurred abundantly in July, but this species and also *Rhabdonella elegans, Rh. spiralis* and *Favella campanulla* were found sparsely in August. *Penilia schmackeri, Evadne tergestina, Oikopleura dioica, Oikopleura longicauda, Fritillaria* sp. and *Doliolum tritonis* were also met with frequently. Diatoms consist of *Chaetoceros Lorenzianus, Ch. affinis, Bacteriastrum hyalinum, Ch. compressus, Ch. didymus, Ch. laciniosus,* a small number of *Thalassionema nitzschioides, Thalassiothrix Frauenfeldii* and significant amount of oceanic forms. The dominant forms are all distinct neritic or inlet-water species and their appearance reflects the warm water condition.

From September to October in 1951: The plankton community differed from that of the preceding period in quantity and quality. Important copepods decreased remarkably and the percentage composition varied considerably as shown in the figures, although the occurring members were almost unchanged. *Oithona similis, Microsetella rosea, Paracalanus parvus* and *Oithona nana* were important species and accompanied by *Oncaea, Corycaeus, Calanus darwinii, Calanus helgolandicus, Calo-*

calanus sp., *Eucalanus attenuatus*, *Lucicutia flavicornis*, *Paracalanus aculeatus*, *Centropages yamadai*, *Oithona plumifera*, *Setella gracilis*, *Euterpe acutifrons*, *Oithona falax* of copepods, *Sagitta enflata*, *Oikopleura longicauda* and a tintinnid *Epiplocylis undilla* var. *blonda*. Of diatoms *Chaetoceros coarctatus*, *Ch. diversus*, *Ch. messanensis*, *Ch. peruvianus*, *Ch. dadayi*, *Ch. pseudocurvisetus*, *Bacteriastrum commosum*, *Rhizosolenia robusta*, *Rh. bergonii*, *Rh. cylindrus*, *Rh. calcar avis*, etc. were tropical members, and the tropical feature of plankton was maintained distinctly till November. The occurrence of neritic and inlet-water copepods, *Oithona rigida* and *Acartia spinicauda*, was also noticeable in this period. As mentioned previously the dominancy of oceanic plankton in the autumn of 1951 was very remarkable.

From November to December in 1951: The tropical forms gradually decreased and attained to the minimum at the end of December. The plankton was composed of local stocks consisting chiefly of *Oithona nana*, *Oithona rigida*, *Acartia spinicauda* and a small number of *Paracalanus parvus*. The associated forms with these copepods were almost similar to those in the preceding period.

From January to February in 1952: The plankton, especially phytoplankton, was very poor in quantity and also in number of species, here the occurrence of a cold water-form *Chaetoceros socialis* was noticeable. Copepods were dominated by *Oithona nana*, *Acartia clausi*, *Oithona similis* and *Paracalanus parvus*, although some oceanic forms still remained. Tintinnids, *Favella taraikaensis* and *Tintinnopsis radix* occurred in this period.

From March to May in 1952: The plankton was characterized by the dominant copepods: *Acartia clausi* and *Oithona nana* at the inner stations, and *Oithona similis* and *Paracalanus parvus* at the outer. *Favella taraikaensis* was widely distributed, but especially it was numerous at the inner stations. Cirripedian nauplii, *Penilia schmackeri* and *Evadne tergestina* occurred in the middle of May. The diatoms were represented chiefly by *Ch. Van Heurcki* and *Ch. didymus*, *Nitzschia seriata* began to increase in March, showed a small peak of spring flourishing and decreased rapidly in April, attaining to the minimum in May. The decrease of diatoms seems to show the period when the quantitative change of plankton is going on.

From June to August in 1952: The plankton showed a clear summer association. Zooplankton was characterized by the dominance of copepods as yet, namely by *Oithona* at the inner stations and by *Oithona* and *Paracalanus* at the outer stations. Other important forms were *Oithona similis*, *Acartia spinicauda*, *Microsetella rosea*, *Oncaea media*, *O. venusta*, *Corycaeus* spp., *Setella gracilis* and *Euterpe acutifrons* of copepods, *Penilia schmackeri*, *Evadne tergestina* and *Podon* sp. of Cladocera, *Sagitta delicata*, a large number of *Oikopleura dioica* and *Tintinnopsis radix* and *Tintinnus lusus-undae*. Larval forms occurred considerably. Many warm oceanic forms accompanied to them. Diatoms were most abundant in this period throughout the year as in the preceding year. Important species were *Chaetoceros laciniosus*, *Ch. didymus*, *Ch. affinis*, *Ch. compressus* and *Ch. Lorenzianus*. Other neritic and oceanic diatoms were similar to those occurred in 1951.

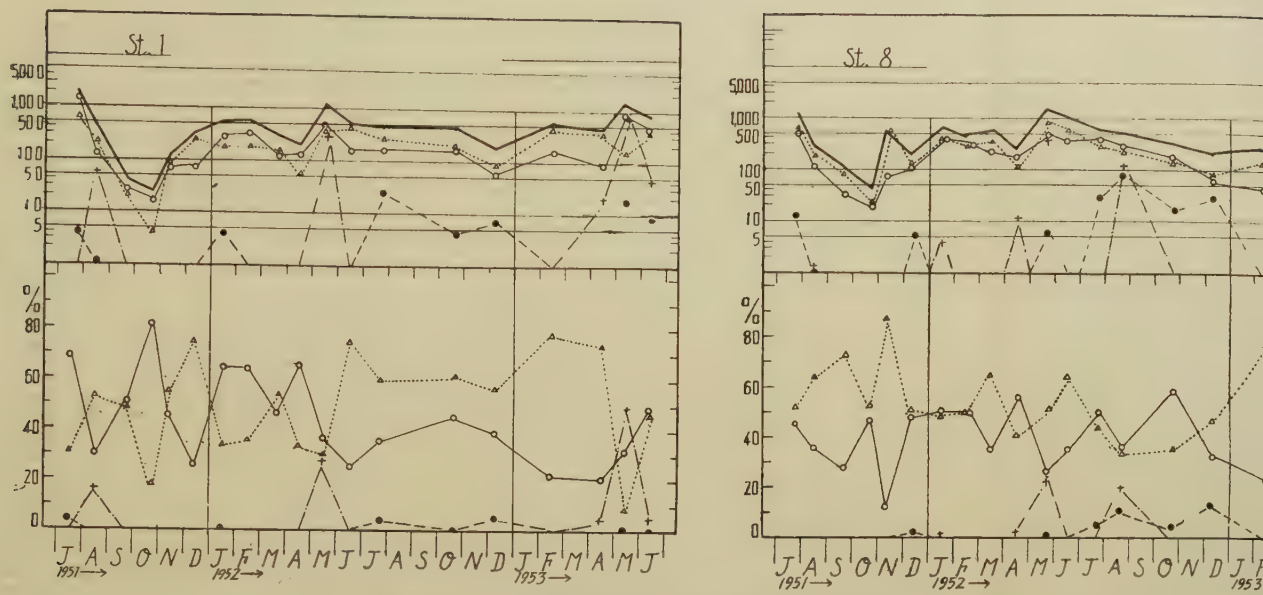


Fig. 9. Seasonal variations of number of zooplankton groups at Stations 1, 8, 13 and 1

—— Total number of zooplankton; —○— Copepod

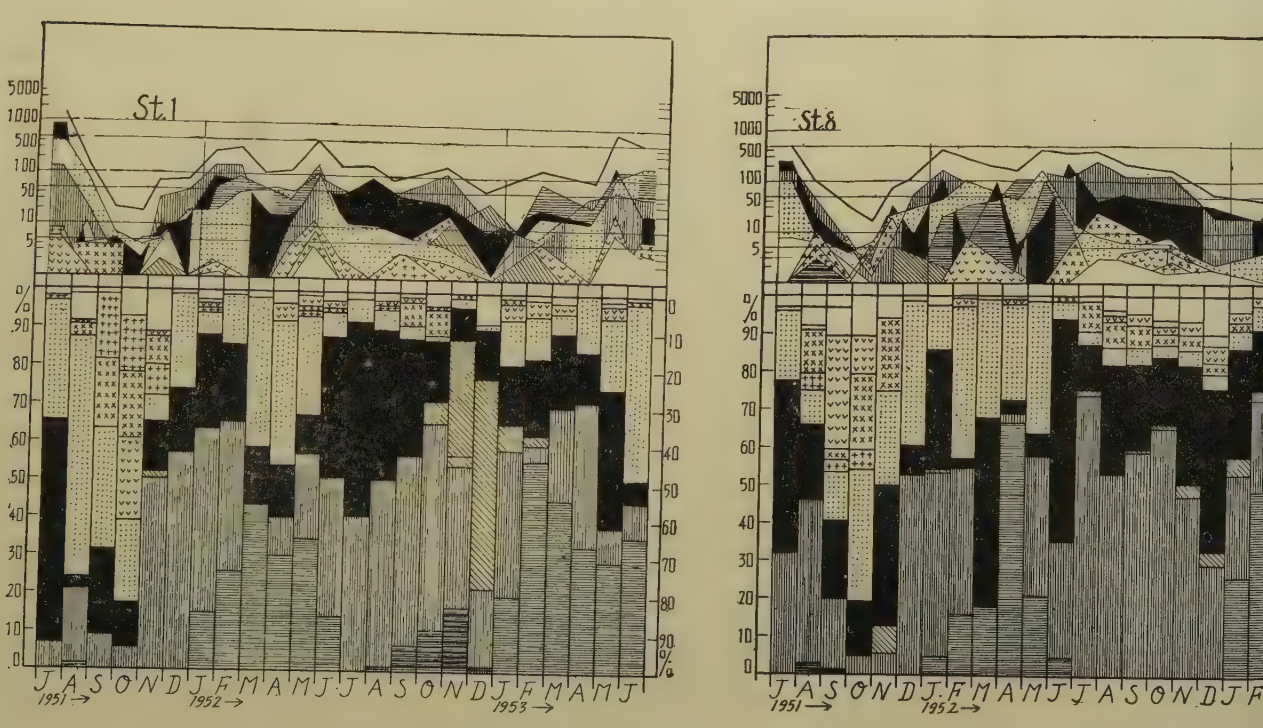
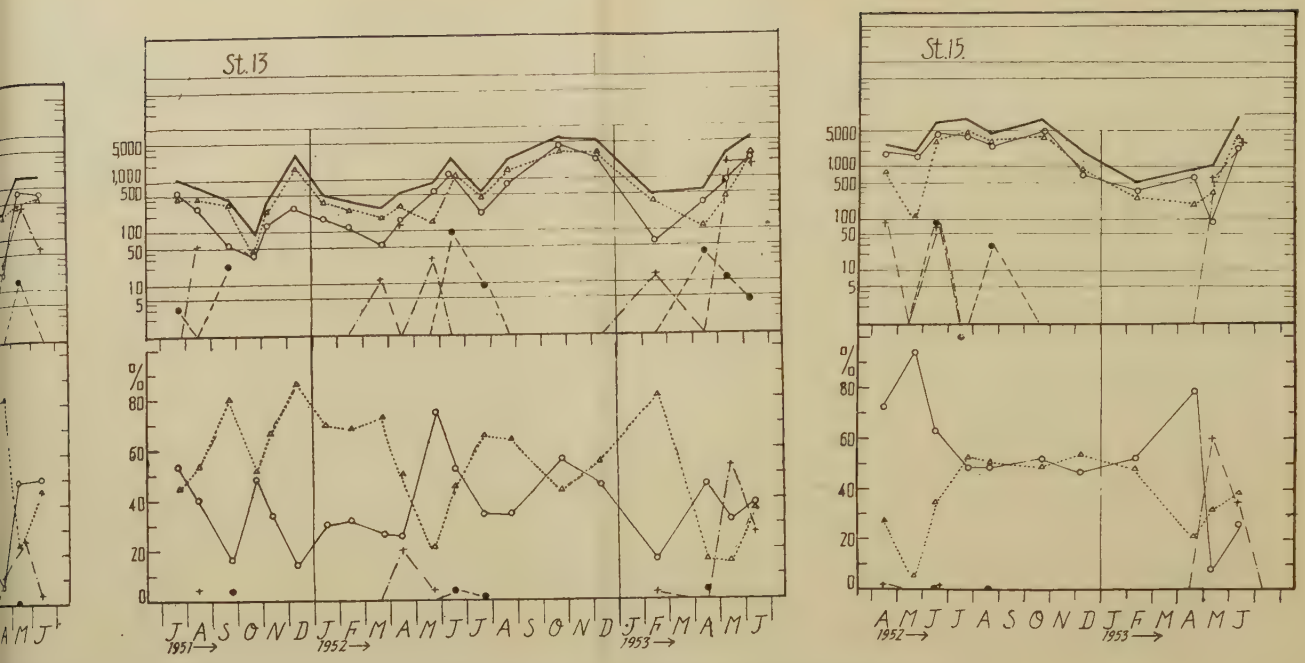


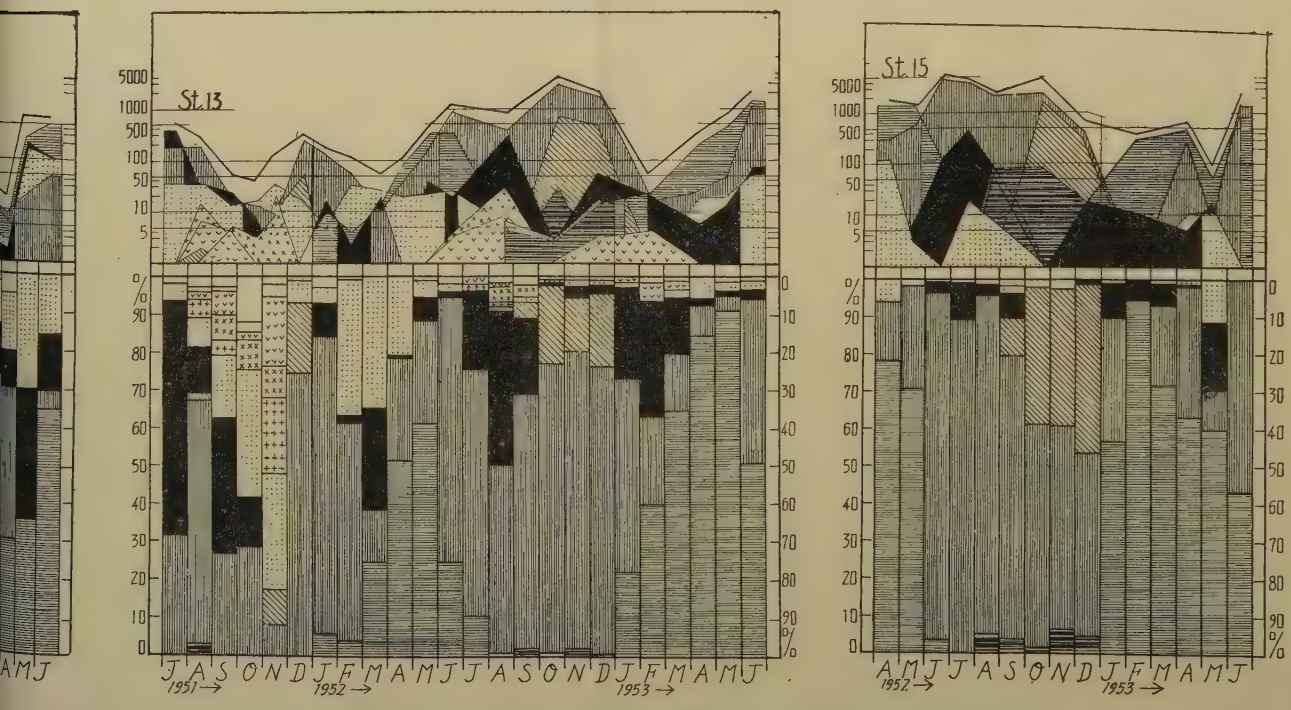
Fig. 10. Seasonal variations of abundance of the important copepods per one meter haul at Stations 1

Acartia clausi
Acartia spinicauda
Oithona rigida
Oithona similis
Corycaeus
Total number of cope



om the inner to the outer part of the bay (above) and their percentage composition (below).

—+— Protozoans; ···△··· Larvae; ···●··· Other animals



13 and 15 from the inner to the outer part of the bay (above) and their percentage composition (below).

Oithona nana
Microsetella
Paracalanus parvus
Oncaea

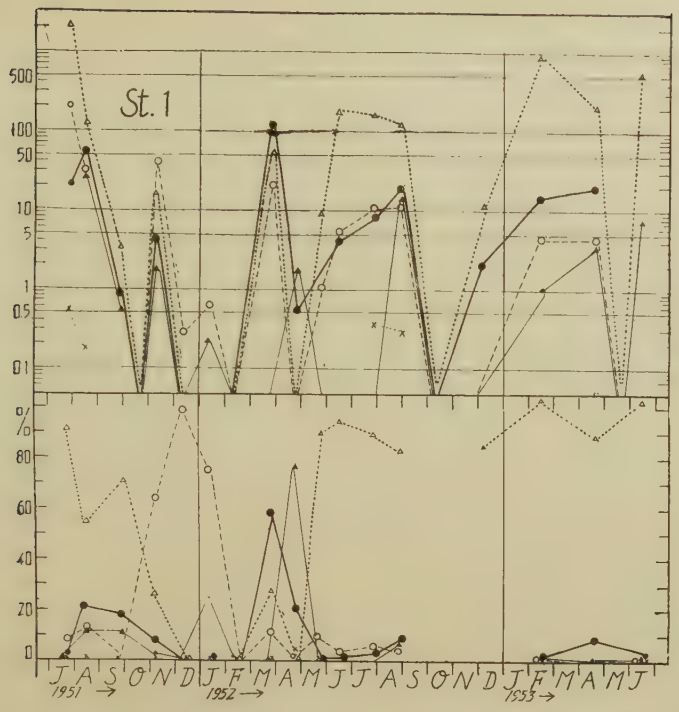
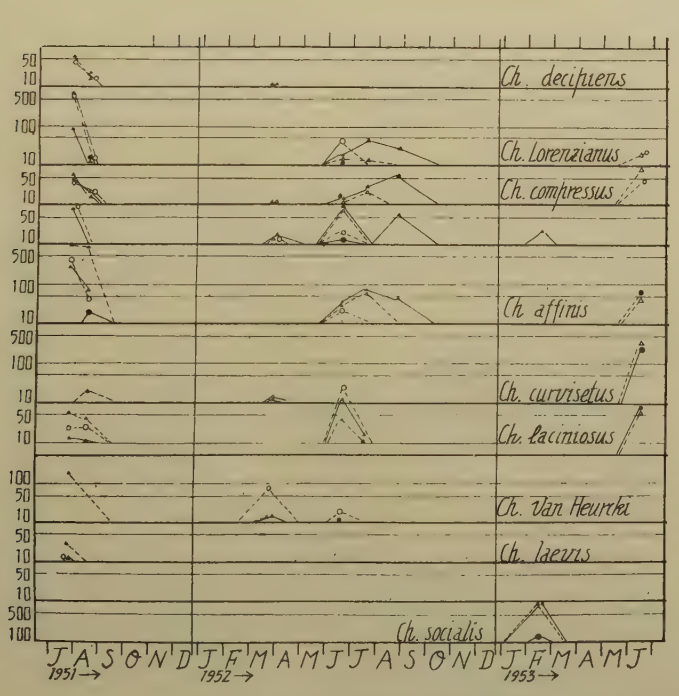


Fig. 11. Seasonal variations of the number of phytoplankton of the main groups per one meter haul at Stations 1, 8
···△··· *Chaetoceros*; —▲— *Rhizosolenia*; ···×···



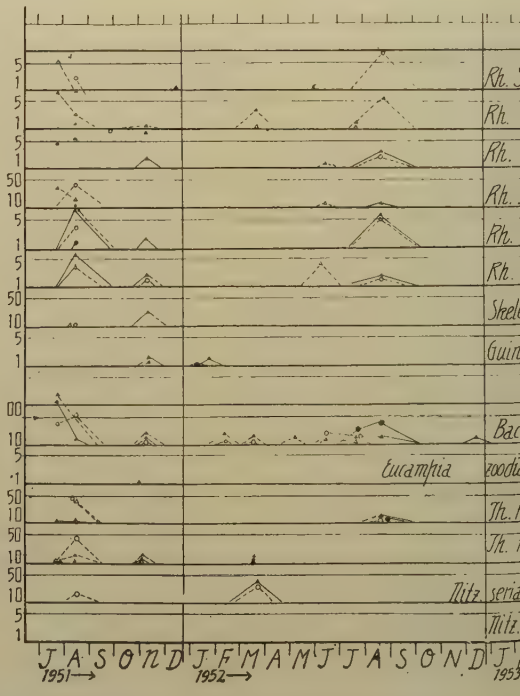
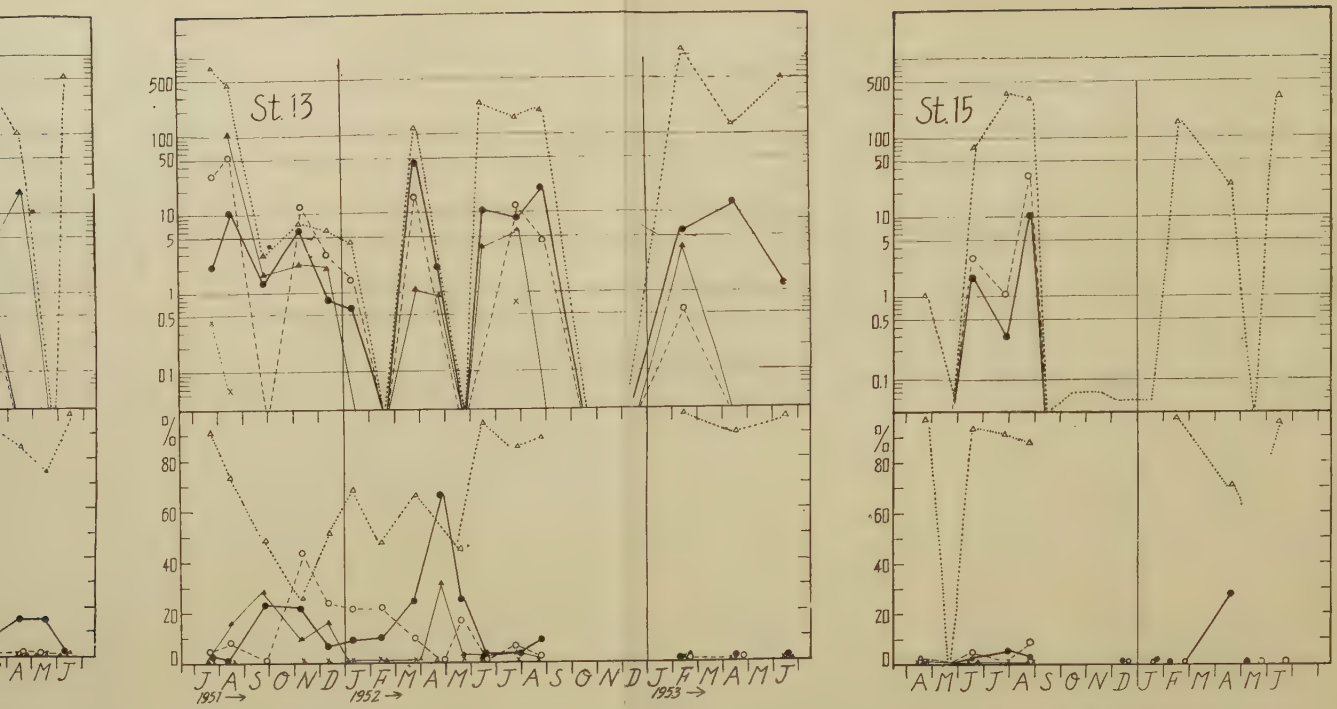
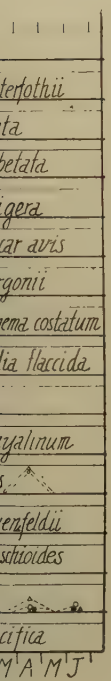


Fig. 12. Seasonal variations of number of the important diatoms per one meter haul from the inner to the outer stations of the bay. Unit of number is thousand.

···△··· St. 1; —▲— St. 8; ···○··· St. 13; —●— St. 15



3 and 15 from the inner to the outer part of the bay (above) and their percentage composition. Unit of number is thousand.
inoflagellata; —●— Pennales; ···○··· Other Centrales



The plankton composition is more stable throughout the year at the inner stations than at the outer stations. In the summer of 1951 the oceanic influx was larger than in 1952, therefore populations was larger than in 1952; therefore populations of inlet water forms, such as *Oithona nana*, *Acartia* and *Paracalanus*, in 1951 were reached the maxima as compared with those in the latter year. On the other hand, the percentages of oceanic and neritic copepods such as *Oithona similis*, *Microsetella rosea*, *Oncaea media* and *Corycaeus* sp. showed comparatively higher values than those of inlet copepods. Diatoms varied remarkably in their composition year by year. In the winter of 1952 the leading species were *Thalassiothrix*, *Thalassionema* and *Nitzschia*, while they were *Chaetoceros socialis* and a small number of *Ch. affinis*, *Ch. didymus* and *Ch. compressus* in the winter of 1953. Main component of copepods seems to be constant, but the percentage composition was more or less variable year after year. For instance, *Oithona nana*, *Acartia clausi*, *Paracalanus* and *Oithona similis* were widely found in winters of both 1952 and 1953, but *Acartia* was scarce in 1952 and *Oithona nana* occurred poorly in 1953. It seems that autumnal community remained still in the bay in the winter of 1952. The diatoms appeared in the winter of 1952 were the neritic temperate water forms which are ordinarily found in this bay till April. Occurrence of these species in the coldest season of 1952 may be accepted as the result of the inflow of the open sea water of relatively high temperature. Contrarily, the occurrence of *Chaetoceros socialis*, a cold water form (Kokubo, 1953) may be attributable to the weakness of the open sea water; in other word, this indicates a strong degree of stagnation of the bay water.

Taizi Bay is a small inlet showing a condensed state of the plankton distribution extending from the innermost part to the open sea; namely all plankton phases from *Oithona* or *Acartia* community to the open sea copepod community are represented in this bay. The bay water is always affected by the influx of the open sea water and consequently the distribution of plankton in this inlet may be considered as indicators of various water masses. The plankton in this bay comprises inlet or neritic and oceanic water forms, and at the same time tropical, temperate and boreal temperate forms. It seems, therefore, to be of great interest to know the degree of stability and the seasonal or regional changes of the plankton distribution in the bay.

The plankton in the bay may thus be divided roughly into the following groups: (1) Local stock occurring throughout the year. (2) Local plankton appearing only in a certain season. (3) The plankton in both neritic and oceanic waters brought into the bay by currents of various nature. In Taizi Bay the spring and early summer communities seem generally to be consisting chiefly of inlet-haunting forms indicated by (1) and (2).

The species of the group (1) are found abundantly in the inner part of the bay and generally euryhaline and eurythermal, such as *Oithona nana*, *Paracalanus parvus* and their nauplii in the inner part, and *Microsetella rosea*, *Oithona similis*, *Oncaea media*, *Corycaeus* sp. and *Oncaea venusta* in the outer part of the bay, of which the

latter 5 species are also distributed widely in the open sea.

The species of the group (2) are extremely euryhaline, but fairly or extremely stenothermal. They occur abundantly in a favourable condition, but survive in the unfavourable season in a small number or in the resting state. Their advents seem to be limited by temperature more strongly than by salinity. The following forms are the representatives of this group in this bay.

(a) Winter form: *Chaetoceros socialis.*

(b) Spring-early summer forms:

Zooplankton—*Acartia clausi, Tintinnopsis radix, Poroecus apiculatus, Favella taraikaensis,* pelecypod and gastropod veligers and polychaete larvae.

Phytoplankton—*Thalassionema nitzschioides, Thalassiothrix Frauenfeldii, Nitzschia seriata, Chaetoceros Van Heurcki, Ch. decipiens* and *Rhizosolenia setigera.*

(c) Summer-autumn forms:

Zooplankton—*Acartia spinicauda, Oithona rigida, Penilia schmackeri, Evadne tergestina,* cirripedian nauplii, *Sagitta delicata, Oikopleura dioica* and *Favella campanulla.*

Phytoplankton—*Chaetoceros laciniosus, Ch. affinis, Ch. Lorenzianus, Ch. compressus, Ch. didymus* and *Bacteriastrum hyalinum.*

Acartia clausi disappeares when the temperature rises beyond 25°C or thereabout, while *Acartia spinicauda* begins to appear when the temperature is about 25°C, being maintained till the temperature falls to ca. 20°C. *Acartia spinicauda* and *Oithona rigida* seem to have the tolerable range of the temperature in the warm season narrower than that of *Acartia clausi* in the cold season.

As the plankton of the group (3), the following forms are known in this bay.

Zooplankton—*Calanus helgolandicus, Cal. darwinii, Cal. minor, Eucalanus attenuatus, Calocalanus pavo, Candacia* spp. *Oncaea* spp., *Sagitta enflata, Oikopleura longicauda, Fritillaria haplostoma, Doliolum tritonis, Salpa* sp., several species of tintinnids and radiolarians.

Phytoplankton—*Chaetoceros coarctatus, Ch. diversus, Ch. dadayi, Ch. messanensis, Ch. laevis, Ch. peruvianus, Ch. pseudocurvisetus, Bacteriastrum commosum, Rh. robusta, Rh. cylindrus, Rh. calcar avis, Rh. imbricata, Climacodium Frauenfeldianum* and *Hemidiscus Hardmanianus.*

Regional Distribution of Plankton

As mentioned above, the seasonal distribution of plankton in the years 1951–1953 may be summarized as follows, although it varies more or less according to the year and the places. *Oithona nana, Paracalanus parvus, Oithona similis, Microsetella, Oncaea media* and *Corycaeus* spp. occurred permanently throughout the year and *Acartia clausi, Acartia spinicauda* and *Oithona rigida* appeared each regularly in the favourable season; these species are very important members in the inlet waters. Their distributions in the bay were as follows:

(1) From February to May:

Acartia clausi–Oithona nana community in the inner part.

Oithona nana–Oithona similis community in the outer part in 1952–1953.

(2) From June to September:

Oithona nana–Paracalanus parvus community in the inner part and mixed community of *Oithona nana–Oithona similis–Microsetella–Oncaea–Corycaeus* in the outer part in 1952.

Oithona nana community in the inner part and *Oithona nana–Paracalanus parvus* community in the outer part in 1953.

(3) From October to January:

Oithona nana–Oithona rigida–Acartia spinicauda community in the inner part and *Oithona nana–A. spinicauda–O. rigida* or *Oithona nana–Paracalanus parvus* community in the outer part of 1952.

Oithona nana–Paracalanus parvus community in the inner part and *Oithona nana–Oithona similis–Paracalanus parvus* community in the outer part in 1951.

The community in the inner part (Sts. 13, 14 and 15) is relatively stable throughout the year as mentioned already for the bays of Kozima, Yosa-naikai, Kumihama, Nakanoumi and Miho (YAMAZI, 1953, 1954) and in the innermost part of Tanabe Bay (YAMAZI, 1955), while that in the outer part of the bay is relatively variable in the percentage composition, although the main constituents of these animal communities are nearly unchangeable all the year round excepting a few forms occurring seasonally.

Relations between the Distribution of Plankton and the Environment

The distribution of plankton community is affected much by the embaymental condition. Although the plankton community in the open sea keeps the uniformity of a certain degree in a wide area, that in the inlet waters shows a great deal of differences regularly occurring from place to place within a relatively small area. The main cause of such variations is the difference in the embayment degree in inlets or bays as already noticed previously (YAMAZI, 1951–1955). Various inlet-inhabiting organisms occurring in a great quantity and distributed regularly are applicable as good indicators of the environmental conditions, if the seasonal successions of these forms are strictly analysed.

The plankton distribution is also largely influenced by the one-side wind. The prevailing wind in the province including Taizi Bay blows from the north-west in winter and spring, from the north-east in early summer and autumn, and from the south-west in summer. The direct result of the one-side wind is the horizontal movement of some plankton components in the inlet as mentioned in the study of Tanabe Bay (YAMAZI, 1955). The summer and early autumn winds cause stowing

of the surface water at the inner region of the bay during the long period from June to September, consequently the inlet plankton communities is restricted to the relatively small areas in the inner part and the open sea water is brought into the bay near the inner region. However, northerly winds during the period from late autumn to spring carry out the inner surface water, therefore the plankton of the inner region of the bay is now distributed in a larger area and found abundantly even in the outer part of the bay. In addition to the direct influence mentioned above, various currents, tidal or non-tidal, affected by the one-side wind may also give a serious indirect influence upon the composition of the inlet plankton communities (Yamazi, 1955).

Biological Conditions of the "Buri" Fisheries

The fishing of yellowtail *Seriora quinqueradiata* Temminck et Schlecel (Japanese name "Buri") by the kiddle net begins to catch in the outer region of Taizi Bay in late December. The fishes are induced into the kiddle along the shore of the coastal line. Uda and Honda (1934) reported the existence of a certain correlation between the catches and the water temperature of the fishing ground, namely the duration of the fishing period between the first and the last catches is longer than usual, when the average water temperature is lower in March than in January and when the rising of water temperature is slower than in average year. Miyamoto *et al.* (1954) reported on the fishing situations of the yellowtail on the Pacific coast during 1950–1953. The predominant catches were found in the fishing period of 1952, and during the next fishing season of 1953 the catches were smaller than during 1952. They found also that the abundant fishery of the yellowtail is in a close correlation with the development of the low atmospheric pressure. During our observations heavy catches were met with during the period from January to March in 1952, while in 1953 catches declined; moreover fair catches in this year were observed one month later than in 1952. As mentioned previously the composition and amount of plankton and the hydrological conditions of the bay differed distinctly between these two years. Thus, these planktological and hydrological differences are considered to be correlated directly or indirectly with the distribution of small-sized plankton predators and at the same time with the intrusion of yellowtail.

Summary

1. The seasonal quantitative and qualitative successions of plankton in Taizi Bay were studied during the period from July, 1951 to June, 1953.

2. There are two peaks in each of the total volume and number of plankton, one in winter and the other in summer; besides a small peak in autumn only in 1952. Seasonal successions of zoo- and phytoplankton communities are varied regionally.

3. Copepods and their nauplii are always predominant in the bay, while Copelata,

Chaetognatha, Cladocera, tintinnids, veligers, Cirripedian nauplii and other larval forms are significant only at the time when they occurred abundantly.

4. The plankton in the bay is divisible into three groups according to their origins and duration of their occurrence, because the plankton in this bay originates mostly from the local or neritic stocks and partly in the oceanic waters and the plankton composition in the bay differs seasonally and from year to year.

5. The regional distribution of the plankton is discussed. The plankton community in the inner region is more stable than in the outer region of the bay all the year round. Although the percentage composition of plankton is variable, the occurrence of main species is maintained throughout the year excepting a few forms.

6. Yellowtail *Seriola quinqueradiata* TEMMINCK et SCHLEGEL (Japanese name "Buri") fishing by kiddle net in the season from winter to spring is affected much by hydrological and biological conditions. The quantity of catches is correlated directly or indirectly with differences in the plankton communities, since the plankton is evidently applicable as a distinct indicator of the biological conditions of the fisheries.

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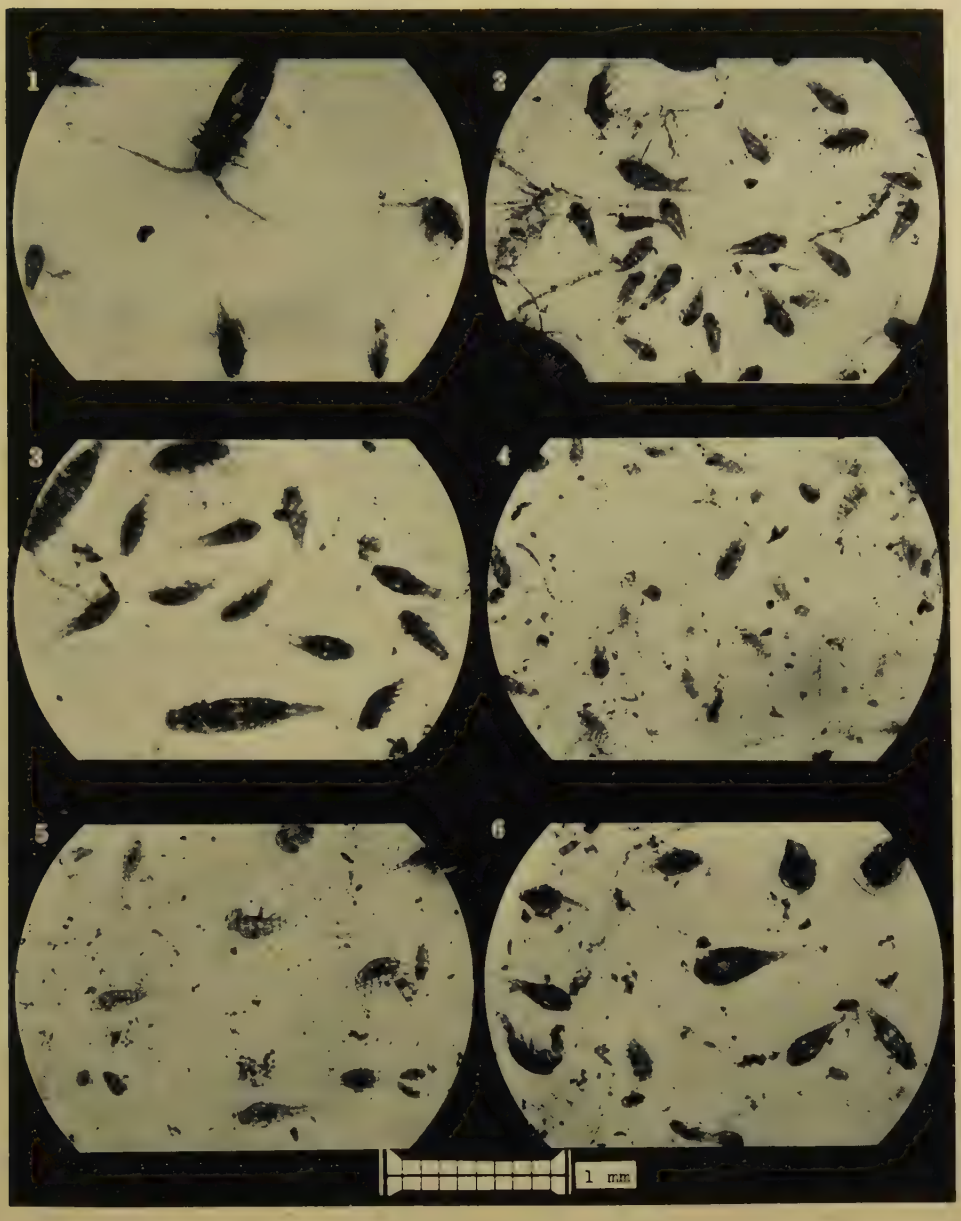
EXPLANATION OF PLATES XXI-XXII

PLATE XXI

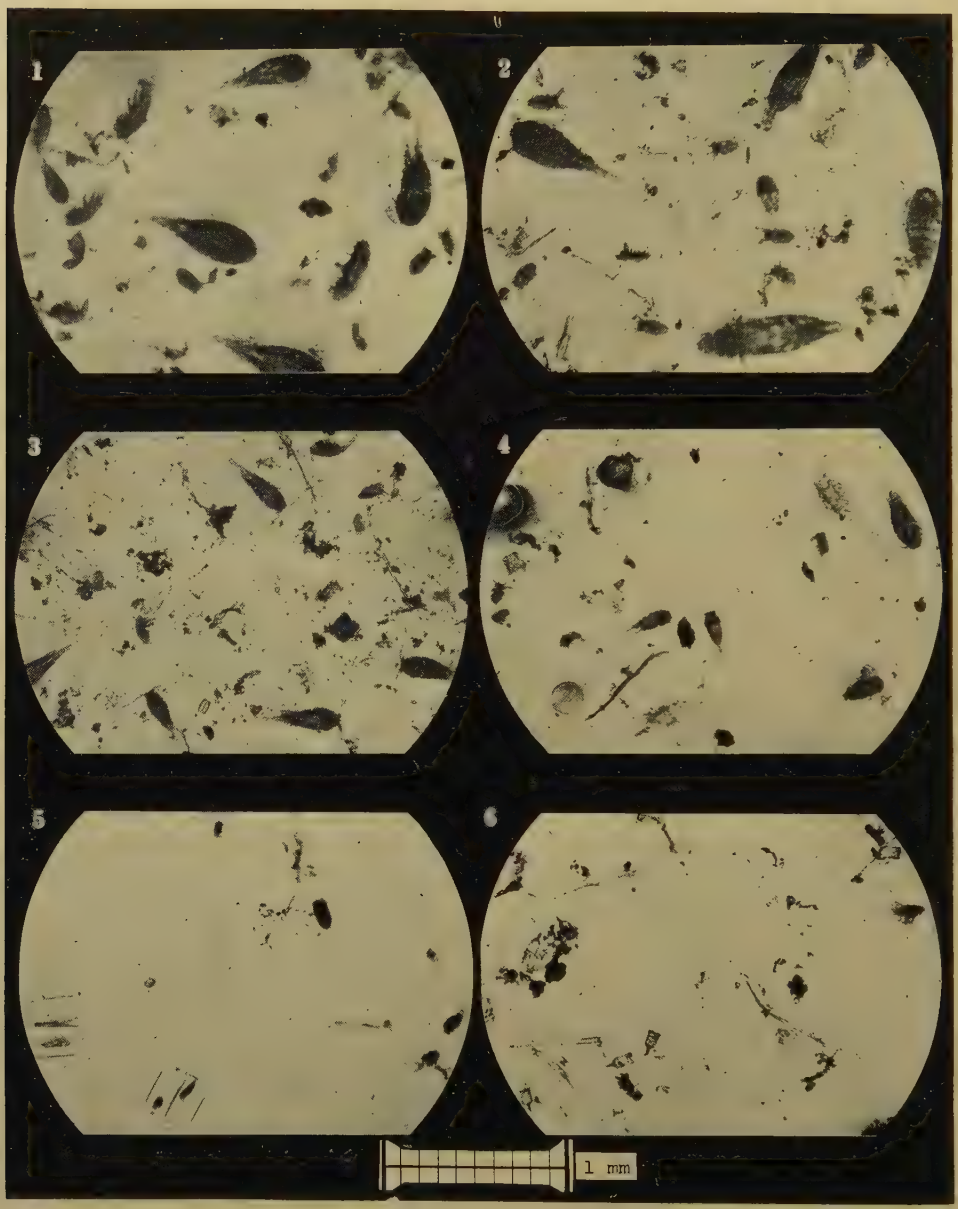
Fig. 1. Example of plankton from catches at the innermost station 15 in Taizi Bay on April 6, 1952.
Fig. 2. The same on May 13, 1952.
Fig. 3. The same on June 15, 1952.
Fig. 4. The same on July 28, 1952.
Fig. 5. The same on August 26, 1952.
Fig. 6. The same on September 23. 1952.

PLATE XXII

Fig. 1. Example of plankton from catches at the innermost station 15 in Taizi Bay on October 10, 1952.
Fig. 2. The same on November 30, 1952.
Fig. 3. The same on January 17, 1953.
Fig. 4. The same on February 14, 1953.
Fig. 5. The same on April 1, 1953.
Fig. 6. The same on April 13, 1953.



I. Yamazi and T. Horibata: Plankton Investigation in Inlet Waters, XVIII.



I. Yamazi and T. Horibata: Plankton Investigation in Inlet Waters, XVIII.

STUDIES ON THE JAPANESE TRECHINAE (III) (COLEOPTERA, HARPALIDAE)

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With 11 Text-figures

Numerous species of the carabid-beetles have been known to be semiaquatic. The habitats of most of those species are adjoining inland waters and only a very few members of them penetrate into the sea. The studies on the marine beetles are, however, one of very interesting subjects to Coleopterologists. A most remarkable feature in the advanced marine forms is a striking morphological resemblance to cavernicoles, that is, the depigmentation of integument, the degeneration of eyes and of metathoracic wings, and so on. Beautiful examples of such adaptations are found in the species belonging to the Trechid subtribe Aepi. In Japan the Coleopterological researches for the intertidal fauna have long been drawn only a little attention, but there are fairly many species inhabiting the intertidal zones on the coast of the insular country.

The present paper deals with three genera, namely, *Perileptus*, *Sakagutia* (new genus) and *Armatocillenus*, all of which contain the marine species. At the same opportunity, adding to the descriptions of the marine forms, the Japanese representatives of the genus *Perileptus* are also enumerated. One of the new species described below was studied in collaboration with Mr. Akinobu Habu of the National Institute of Agricultural Sciences.

This study was started in the Entomological Laboratory of the University under the superintendence of Prof. Syunro Utida and was completed in the Zoological Institute under the guidance of Prof. Kenji Nakamura, while it had always been supported by Prof. Takasi Tokioka of the Seto Marine Biological Laboratory. The writer wishes to express his hearty thanks to these professors. Best gratitudes are also due to the following gentlemen who were kind enough to supply him with either many interesting material or useful information and literature: Prof. Teiso Esaki of Kyushu University, Mr. Hiroshi Ishida of Hyogo Agricultural College, Mr. Ryôsuke Ishikawa of Tokyo, Mr. Einar Klefbeck of Falun, Sweden, Mr. Kazuyoshi Kurosa of Saéki City, Mr. Yoshihiko Kurosawa of National Science Museum, Mr. Katsura Morimoto of Kyushu University, Mr. Takehiko Nakane of Saikyo University, Mr. Kohei Sakaguti of Nishinomiya City, Mr. Kazuo Tanaka of Funabashi City, and Mr. Yasunobu Yasue of Ôhara Institute for Agricultural Biology.

Genus *Perileptus* SCHAUM

Perileptus SCHAUM, 1860; type-species: *Carabus areolatus* CRÉUTZER, 1799.——PUTZEYS, 1870, Ent. Ztg., Stettin, **31**: 9, 362.——GANGLBAUER, 1892, Käf. Mitteleur., **1**: 185.——JACOBSON, 1906, Käf. Russl., (4), 296.——REITTER, 1908, Fauna Germ., **1**: 126; 1909, in BRAUER, Süsswasserfauna Dtschl., (3-4), 128.——JEANNEL, 1922, Ann. Soc. ent. France, **90**: 340; 1923, Ann. Mag. Nat. Hist., (9), **12**: 396; 1926, L'Abeille, **32**: 401, 402; 1941, Faune de France, **39**: 301; 1946, Faune Emp. Franç., **6**: 322.——TOSAWA, 1935, Kansai Konchu Zasshi, **3**: 22.——ANDREWES, 1935, Fauna Brit. Ind., Col. Carab., 2: 48.——S. UÉNO, 1953, Shin Konchû, Tokyo, **6**, (11): 38.

Ochthephilus NIETNER, 1857, Ann. Mag. Nat. Hist., (2), **20**: 275; type-species: *Ochthephilus ceylanicus* NIETNER, 1857.——JEANNEL, 1922, Ann. Soc. ent. France, **90**: 165.

In Japan the genus *Perileptus* has been represented by a single species, *P. japonicus*, which has originally been described by H. W. BATES from Hiogo (1873, p. 296) and has been reported also from China and Celebes (JEANNEL, 1920, p. 108; 1923, p. 397; 1926, p. 414). In examining a good deal of this common species, the writer has found that there are three distinct species among the specimens hitherto considered as one species, *P. japonicus*. Moreover, the writer has discovered another new marine species of this genus on the Pacific coast of the Island of Shikoku. These four Japanese species will be distinguished by the following features.

Key to the species

1 (2) Body somewhat brownish black; small species (1.85-2.25 mm), with rather small eyes and distinct oblique genae ..... *P. morimotoi* sp. nov.

2 (1) Body more or less brownish, not black.

3 (4) Genae very short, not convex; eyes large and prominent, pronotum widest at about apical one-fourth, with sides well rounded; length: 2.55–2.85 mm. ..... *P. japonicus* H. W. BATES*

4 (3) Genae conspicuous and subangulately convex; eyes smaller, less prominent, pronotum widest at about apical one-fifth, with sides faintly rounded.

5 (6) Larger (2.9–3.5 mm); front depressed behind clypeal suture, front margin of labrum with a central tubercle, and elytral striae with finer punctures ..... *P. laticeps* sp. nov.

6 (5) Smaller (2.45 mm); front not depressed behind clypeal suture, front margin of labrum without tubercle, and elytral striae with coarser punctures ..... *P. naraensis* sp. nov.

Perileptus (s. str.) *morimotoi* S. UÉNO, sp. nov.

(Figs. 1–2)

Perileptus (s. str.) *morimotoi* S. UÉNO, 1953 (*in litt.*), Shin Konchû, Tokyo, **6** (11): 39, fig. 4, upper left.

Length: 1.85—2.25 mm (from front margin of clypeus to anal end).

Winged. Body elongate and depressed; pubescence dense but short. Somewhat

* *Perileptus japonicus* H. W. BATES, 1873, Trans. Ent. Soc. London, 296.—JEANNEL, 1920, Ann. Mag. Nat. Hist., (9), **5**: 108; 1923, *loc. cit.*, (9), **12**: 397; 1926, L'Abeille, **32**: 406, 414, figs. 188, 189.—TOSAWA, 1935, Kansai Konchu Zasshi, **3**: 23, pl. 2, fig. 9.—S. UÉNO, 1953, Shin Konchû, Tokyo, **6** (11), p. 39.

brownish black, head with black band between eyes, elytra with apical margin yellowish brown; clypeus, labrum, mandibles, propleura and epipleura brown to dark brown; palpi, proximal four segments of antennae (rest becoming darker towards apex) and legs pale yellowish brown to yellowish brown.

Head large, flat on surface, but with curved frontal furrows so deep in front that both front and supraorbital areas are moderately convex; eyes moderate in size, prominent; genae distinct, much shorter than eyes and hardly convex; clypeal suture evident and nearly straight, front margin of labrum deeply emarginate and without central tubercle; neck wide; surface moderately punctate, microsculpture composed of distinct reticulation; antennae stout, extending a little beyond basal one-fourth of elytra.

Pronotum subcordate, moderately convex, about 1.1 times wider than head, about 1.35 times wider than long, widest at about apical one-fifth and contracted behind; sides rounded faintly in front and sinuate behind; apical border slightly but widely emarginate, base narrower than apex, about five-sixths as wide as the latter, produced at middle and distinctly emarginate on each side; front angles rounded, hind angles projected on each side as a small acute tooth and each with a short carina; median line deep, basal foveae small but distinct, merging inwardly into basal transverse impression which is uneven; surface distinctly and rather closely punctate; microsculpture consisted of well marked isodiametric meshes.

Elytra elongate, moderately convex at sides but flat on disk; about 1.25 times wider than pronotum, about 1.75 times longer than wide (the ratio somewhat variable according to individuals); sides slightly rounded, hardly emarginate before apex, shoulders obvious; striae impunctate, 1—5 distinct though shallow, stria 1 becoming deeper towards apex but very faint or nearly disappearing near base, 2—5 disappearing behind, others obsolete, apical striole vanished so that umbilicate pores isolated; intervals flat, with irregular rows of fine punctures; interval 3 with three dorsal pores adjoining stria 3, located at basal one-sixth to two-ninths, a little behind middle and about apical one-fourth respectively, of these pores, basal two distinct, while apical one rather indistinct; isodiametric microsculpture well developed throughout.

Protibiae without external groove.

Male genital organ weakly chitinized. Aedeagus elongate, slightly arcuate and with membraneous basal part, apical part wide, apex produced into narrow snout; inner sac inerm. Styles short, subequal in length, each provided with two long apical setae.

Holotype: ♂, allotype: ♀, the estuary of the Niyodogawa River, Suzuré, Kôchi Pref., Shikoku, 4—IV—1953, collected by K. Morimoto.

Paratypes: 6 ♂♂, 2 ♀♀, from the same locality with that of the holotype, 25—III—1953, by S. Uéno and K. Morimoto; 7 ♂♂, 17 ♀♀, from the same locality, 4—IV—1953, by K. Morimoto.

All the type-specimens are deposited in the writer's collection.

The present new species inhabits the sandy beach of the intertidal zone and becomes submerged completely at high-water. It was obtained in association with *Armatocillenus yokohamae*, *Peryphus aureofuscus* and a small undetermined Staphylinid.

Perileptus (s. str.) *laticeps* S. Uéno, sp. nov.

(Figs. 4-6)

Length: 2.9—3.5 mm (from front margin of clypeus to anal end).

Winged. Body elongate and depressed; pubescence rather dense and formed by fairly long hairs. Reddish brown to dark reddish brown, head with obscure dark band between eyes, elytra somewhat lighter than fore-body, ventral side darker than dorsal surface; palpi pale, proximal four segments of antennae (segments 5 -11 dark) and legs pale reddish brown.

Head large and wide, flat on surface, with deep curved frontal furrows which are widening out anteriorly into the depression of front, though this depression of the front varies to a certain degree according to individuals; surface sparsely and slightly punctate, punctures rather denser at sides; microsculpture vanished; clypeal suture distinct, well curved, front margin of clypeus slightly arcuate; front margin of labrum emarginate and with a central tubercle; eyes prominent but rather small; genae conspicuous, subangulately convex and with a few fairly long hairs; neck wide; antennae long and stout, reaching basal one-third of elytra, slightly dilated towards apex.

Pronotum subcordate, a little convex or, so to say, rather flat, about as wide as or a little wider than head according to individuals, about 1.2 times wider than long, widest at about apical one-fifth and contracted behind; sides faintly curving round from widest part to hind angles and sinuate just before them, which are projected on each side as a small acute tooth (the sharpness of this tooth is variable according to individuals) and each with a short carina, front angles rounded; base fully three-fourths as wide as apex, well produced at middle and emarginate on each side, the hind margin of produced part nearly straight; median line fairly wide and deep, basal foveae distinct, merging into basal transverse impression which is slight at middle; surface rather closely punctate, without appreciable microsculpture, basal area rugose.

Elytra elongate, with nearly parallel sides, and flat; about 1.3 times wider than pronotum, about 1.8 times longer than wide; shoulders distinct and rounded; striae shallow, punctured, only stria 1 entire and deepening towards apex, 2 to 5 disappearing behind, others obsolete, apical striole shallow; intervals slightly convex, with irregular rows of minute punctures; two indistinct dorsal pores present on stria 3; nearly isodiametric microsculpture visible especially on both sides.

Protibiae without external groove.

Male genital organ weakly chitinized. Aedeagus wide, with membraneous basal

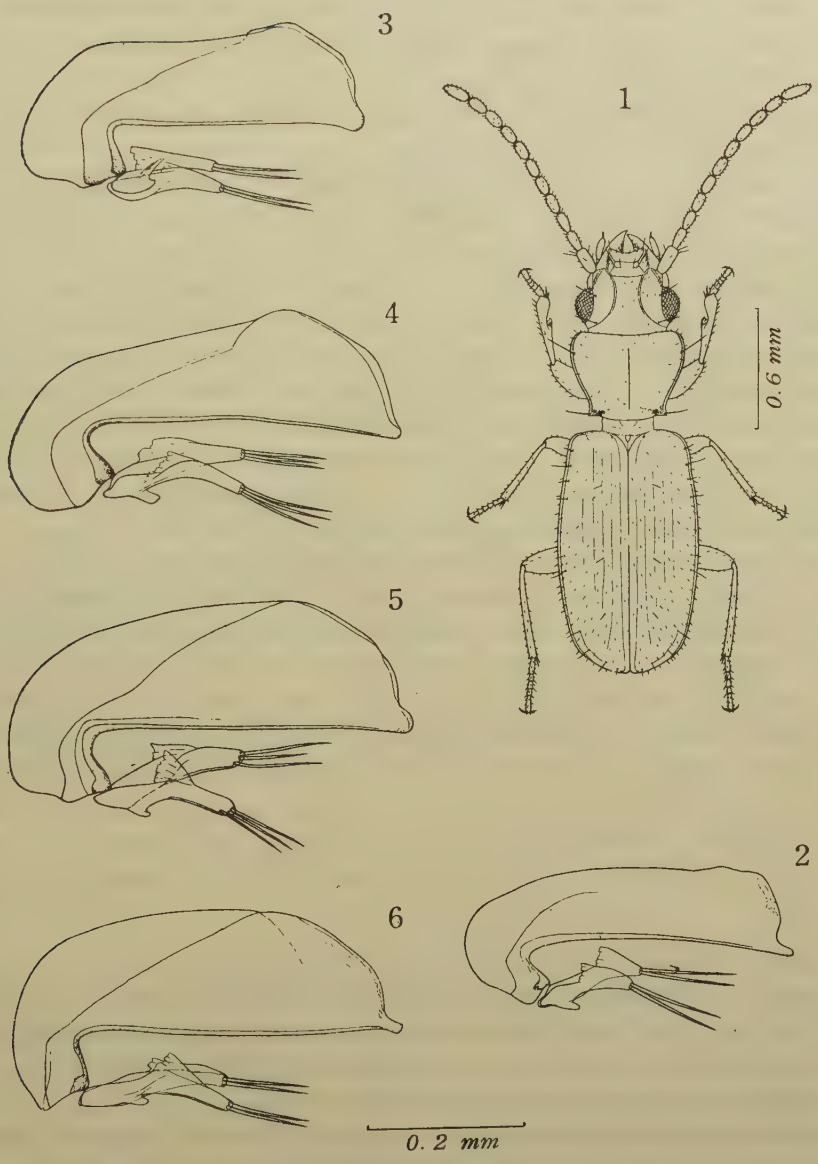

Fig. 1. *Perileptus morimotoi* S. UÉNO, sp. nov., ♂, of the Niyodogawa River.
Figs. 2–6. Male genital organ, left lateral view.
2. *Perileptus morimotoi* S. UÉNO, sp. nov., of the Niyodogawa River.
3. *Perileptus naraensis* S. UÉNO, sp. nov., holotype, of Mt. Kasuga.
4. *Perileptus laticeps* S. UÉNO, sp. nov., holotype, of the Inukamigawa River.
5. Same species, of the Hôfukujigawa River.
6. Same species, of the Takanogawa River.

part; apex produced, varying in shape, rounded in most cases; inner sac inerm. Styles short, but comparatively a little longer than the other Japanese species of the genus, subequal in length, each provided at apex with two, three or four setae according to individuals.

Holotype: ♂, allotype: ♀, the Inukamigawa River, by Kanaya, Shiga Pref., Honshu, 3—V—1952, collected by H. ISHIDA.

Paratypes: 5 ♂♂, 4 ♀♀, the Takanogawa River, by Yase, Kyoto, Honshu, 31—III—1952, by H. ISHIDA; 1 ♂, the Hôfukujigawa River, Nishigori-mura, Higashi-Chikuma-gun, Nagano Pref., Honshu, 19—VI—1952, by S. UÉNO.

The type-specimens are deposited in the writer's collection. At each locality it was found under pebbles on the exposed river-bed, coexisting with *P. japonicus*.

This new species resembles both *P. areolatus* and *P. japonicus*, but may easily be distinguished from those species by the distinctly wider fore-body, the shape of the pronotum which is widest more in front and with the sides distinctly less rounded, and by many other characteristics described above. The depression of the front behind the clypeal suture is unusual in the genus *Perileptus*, which somewhat resembles the feature described as regards the genus *Neoblemus*.

This species is noticeable in the variability in the structure of the male genital organ. In the holotype and a specimen from the Hôfukujigawa River, the apical setae on each style are three in number, while in the Yase specimens they are two or four according to individuals, even though they were found living in the same habitat. In an individual from Yase, the apex of aedeagus is produced into a narrow snout, while in all the others it is rounded. After a careful examination, no other external differences are detectable, and all these examples are regarded as one species.

Perileptus (s. str.) *naraensis* S. UÉNO, sp. nov.

(Fig. 3)

Length: 2.45 mm (from front margin of clypeus to anal end).

Winged. Body elongate and depressed, but less than in *P. laticeps*; pubescence fairly long and rather sparse. Dark brownish red, head with blackish band between eyes, ventral side of the hind-body darker; palpi pale, antennae reddish brown with basal segment somewhat lighter, legs paler reddish brown.

Head wide, with deep curved frontal furrows, supraorbital areas and front convex, the latter without depression behind clypeal suture which is evident and moderately curved; front margin of labrum evenly emarginate, without a central tubercle; eyes small, a little prominent; genae remarkable, subangulately convex and with a few long hairs; neck rather narrow; vertex sparsely and finely punctate, punctures coarser and a little denser on both sides, especially on supraorbital areas; microsculpture absent; antennae stout, distinctly shorter in proportion than in *P. laticeps*.

Pronotum subcordate, a little convex, about 1.1 times wider than head, fully 1.2

times wider than long, widest at about apical one-fifth and contracted behind; sides faintly rounded and sharply sinuate before hind angles which are projected on each side as an acute tooth and each with a short carina, front angles rounded; base produced at middle and emarginate on each side, about four-fifths as wide as apex; median line distinct, deep, a little widening behind, basal foveae deep, merging into basal transverse impression; surface finely and rather sparsely punctate, without visible microsculpture, basal area rugoso-punctate.

Elytra rather short, moderately convex though rather flat on disk, 1.3 times wider than pronotum, 1.7 times longer than wide, widest at about apical two-fifths; sides slightly rounded, shoulders distinct; striae 1—5 well marked, rather deep, coarsely punctured, only stria 1 entire and deepening towards apex, others disappearing both near base and near apex, except stria 5 which is traceable to basal border, apical striole shallow; intervals slightly convex, with irregular and rather sparse rows of minute punctures; two indistinct dorsal pores present but hardly distinguishable from the punctures in stria 3; reticulate microsculpture present but very indistinct.

Protibiae without external groove.

Male genital organ weakly chitinized. Aedeagus wide, with membraneous basal part; apical part large, with apex rounded; inner sac inerm. Styles short, subequal in length, each provided with two long apical setae.

Holotype: ♂, Mt. Kasuga, Nara, Honshu, 23—IX—1948, collected by S. Uéno. The type is preserved in the writer's collection. It was discovered under a large stone by a stream in the forest.

The present new species is closely allied to *P. laticeps*, but differs from that in many features, *i. e.*, decidedly smaller in size, head narrower and more convex, with distinctly narrower neck, not anteriorly depressed front, front margin of labrum not tuberculate at middle, each antennal segment distinctly shorter, pronotum a little wider at base, elytra shorter and more convex, and with coarser punctures in the striae.

Genus *Sakagutia* S. Uéno, gen. nov.

Type-species: *Sakagutia marina* S. Uéno, sp. nov.

Winged. Body elongate and flat; surface impunctate, glabrous and shiny.

Head large and wide, frontal furrows evident, nearly parallel or slightly converging anteriorly and extending a little onto clypeus; eyes rather small, consequently genae remarkable, hind supraorbital pore located far behind the level of hind margins of eyes (as in *Limnaeum*); neck wide, not constricted on dorsal surface; labrum transverse, with front margin nearly straight or a little produced at middle according to individuals; mandibles short, wide, and sharply hooked at apices; mentum with a stout simple tooth, submentum with three setae on each side; ligula quadrate, truncated at apex and bisetose, paraglossae narrow, extending beyond ligula; maxillae hooked at apices and each with rather a few bristles on inner margin; palpi stout,

maxillary palpi with penultimate segment pubescent and strongly dilated at apex, apical segment very small, labial palpi similar to maxillaries, but much smaller and with penultimate segment bearing only a few hairs; antennae filiform, long, with segment 2 evidently shorter than segment 3.

Pronotum transverse cordate, contracted behind; both lateral and postangular setae present; front angles produced, hind angles a little obtuse.

Elytra elongate, shoulders distinct though rounded, basal border not angulate at shoulder and reaching stria 5; punctate-striate, striae all entire, becoming a little deeper towards apex, with the exception of striae 6 and 7 which are free at apices, stria 5 deeper than the others, outwardly sinuate at each dorsal pore and continued to apex without special deepening, so that apical striole is not distinguishable, 8 similar to inner ones, scutellar striole long; intervals 4 and 5 remarkably wider than the others; interval 3 with ten (occasionally nine or eleven) dorsal pores on the middle between striae 2 and 3, stria 5 also with ten (occasionally nine or eleven) dorsal pores; series of umbilicate pores composed of eleven, middle ones of which are sparsely ranged.

Ventral surface glabrous; metasternal process bordered; anal sternite with one seta in ♂, two in ♀ on each side. In ♂ protarsi proximal two segments dilated, produced inwardly at apices and furnished beneath with sexual adhesive hairs.

Aedeagus robust, basal orifice open to right face, with right basal lobe reduced; apex narrowly rounded; inner sac armed with well developed copulatory pieces. Styles subequal in length, each provided with four apical setae.

The present new genus is remarkable in the position of the hind supraorbital pore and the chaetotaxy of elytra, and no close ally is known to the writer.

Sakagutia marina S. Uéno, sp. nov.

(Figs. 7–8)

Length: 4.9—5.4 mm (from front margin of clypeus to anal end).

Body elongate and flat. Shiny black with very weak aeneous tinge, epipleura and apical margin of elytra as well as the median areas of apical sternites brownish; labial palpi, segment 1 and basal parts of segments 2 and 3 of antennae as well as legs brown to dark brown.

Head large and wide, with wide, moderately deep but rather short frontal furrows; eyes rather flat, genae conspicuous, supraorbital area hardly prominent, not forming supraorbital carina; microsculpture consisted of isodiamentric meshes but indistinct on vertex; antennae long, reaching basal one-third of elytra.

Pronotum transverse cordate, moderately convex, about 1.2 times wider than head (a little narrower in ♀ than in ♂), about 1.3 times wider than long, widest at about apical one-third; sides weakly rounded in front and strongly sinuate behind, side-gutter wide but becoming very narrow behind basal sinuation of side-border; apex slightly emarginate, base narrower than apex, its sides oblique and slightly

emarginate; front angles well projected forwards and narrowly rounded at their tips, hind angles nearly rectangular or a little obtuse according to individuals, each with only a trace of carina; median line very deep, reaching neither apex nor base, both front and basal transverse impressions deep, the latter a little uneven, basal foveae large and deep, a few transverse striations present in anterior part of these foveae; microsculpture formed by isodiametric meshes though indistinct on disk.

Elytra elongate, with nearly parallel sides, very flat on disk though well convex at sides, 1.3—1.4 times wider than pronotum according to individuals (a little wider in ♀ than in ♂), about 1.8 times longer than wide; sides slightly emarginate at about two-sevenths from base and at a portion near apex, which is widely rounded; striae deep, rather finely but distinctly punctate, striae 3 and 4 frequently joined together at apex, 6 and 7 shallower than the others; intervals moderately convex, intervals 4 and 5 very wide, the latter suddenly narrowing just behind shoulder so that interval 6 widened there; microsculpture isodiametric throughout.

Male genital organ well chitinized. Aedeagus robust, tapering towards apex, moderately arcuate near base, more strongly near apex, which is produced into rounded end; a band of pubescence present at the proximal end of apical orifice. Copulatory pieces complicated as shown in figure; they are separated as follows: dorsal twisted whip-shaped piece which is flattened at apex, a bundle of fibres beneath the basal part of dorsal whip, and four smaller and lamellar pieces surrounding this bundle of fibres. Dorsal angle of left style distinct but not hooked.

Holotype: ♂, allotype: ♀, Kuno, Shizuoka Pref., Pacific coast of Honshu, 5—III—1939, collected by S. Suzuki.

Paratypes: 2 ♂♂, 1 ♀, Kuno, Shizuoka Pref., 5—III—1939, by S. Suzuki; 1 ♀, Shimizu, Shizuoka Pref., —III—1939, by S. Suzuki; 1 ♂, Sakai-Minato, Osaka Pref., Honshu, 9—IV—1940, by Y. Yano; 2 ♂♂, Kanayama near Shirahama, Wakayama Pref., Honshu, 28—VII—1941, by K. Sakaguti; 1 ♀, Tarumi, west of Kobe, Honshu, 2—IV—1940, by K. Kurosa.

The type-specimens are deposited in the collections of S. Uéno, K. Sakaguti and K. Kurosa.

This interesting new species inhabits the intertidal zone of sandy shore on the Pacific coast in Honshu, and dwells under stones or refuses drifted up by the tide.

Genus *Armatocillenus* Dupuis

Cillenus, subgen. *Armatocillenus* Dupuis, 1912, Ann. Soc. ent. Belg., **56**: 334; type-species: *Cillenus formosanus* Dupuis, 1912.

Bembidion, subgen. *Armatocillenus*, Andrewes, 1938, Proc. R. Ent. Soc. London, (B), **7**: 191. ——Netolitzky, 1942, Koleopt. Rdsch., **28**: 38, 68.

Subgen. *Novicillenus* S. Uéno et Habu, nov.; type-species: *Armatocillenus aestuarii* S. Uéno et Habu, sp. nov.

Subgen. *Desarmatocillenus* Netolitzky, 1942, Koleopt. Rdsch., **28**: 39, 68; type-species: *Cillenus yokohamae* H. W. Bates, 1883.

Subgen. *Corallicillenus* S. Uéno, nov.; type-species: *Armatocillenus tsutsuii* S. Uéno, sp. nov.*

* The description of this new species will be given on pp. 406–408 of this journal.

In 1912 DUPUIS described an interesting Bembidiid-species, *Cillenus formosanus*, collected by SAUTER at Anping in Formosa, for which he established at that time the subgenus *Armatocillenus*. It was described based on a single specimen which seemed to be immature. Later, CSIKI (1928, p. 131) placed it under the genus *Bembidion* (*s. lat.*). ANDREWES (1938, *loc. cit.*) and NETOLITZKY (1942, *loc. cit.*) followed his opinion. *Armatocillenus* has since been regarded as a subgenus of *Bembidion*.

In the Japanese fauna, *Cillenus yokohamae* H. W. BATES is only a species hitherto known to belong to the *Cillenus*-group. CSIKI (1928, p. 131), ANDREWES (1938, p. 193) and JEANNEL (1941, p. 450) considered that the species should belong to *Cillenus*. This seems not to be justifiable, and, moreover, the last named author has quite misunderstood the species. *Cillenus yokohamae* does not agree with the diagnosis of his "série phylétique de *Cillenus*" in many respects, *viz.* the structure of the basal border of the elytra, the chaetotaxy, etc. A year later, NETOLITZKY (1942, *loc. cit.*) settled this species in a new subgenus *Desarmatocillenus* though he did not try to divide the artificial genus *Bembidion* into more natural genera.

The writer has recently obtained two new species belonging to the same group. After a careful study on these material it becomes clear that all the Japanese species are not the close relatives of the European *Cillenus lateralis* and must form a special group. Three subgeneric names are given for the oriental species, *i. e.*, *Chinocillenus*, *Armatocillenus* and *Desarmatocillenus*. The first is evidently different with generic rank from the Japanese species. Of the remaining two, the second name is older than the third. However, there is a question not yet solved whether or not *Armatocillenus* and *Desarmatocillenus* really belong to the same group. The difference in chaetotaxy between these two groups seems to be important, *i. e.*, that in number of the elytral dorsal pores and of the pores on the anal sternite. So long as it is, DUPUIS' original description is still insufficient to decide the matter. So, the writer will treat here the Japanese representatives as the members of *Armatocillenus*, the subject being remained in the future.

The Japanese species of the genus *Armatocillenus* are defined as to have the following combination of morphological features:

Body elongate; surface impunctate and glabrous, with more or less distinct isodiametric microsculpture; metathoracic membraneous wings well developed or rudimentary. Colour veriable.

Head large and wide, surface rather flat, with distinct, wide and parallel frontal furrows which are extending anteriorly onto clypeus; neck wide, not constricted; labrum transverse; mandibles remarkably long, stout and hooked at apices; mentum with a simple tooth, submentum with three setae on each side; ligula quadrate, bisetose, with apical margin truncated or slightly arcuate, paraglossae, narrow, extending a little beyond ligula; maxillae with rather a few bristles on inner margin; palpi long, apical segments very small and subulate, penultimate segments elongate,

each of them dilated towards apex and sparsely pubescent; antennae stout, filiform to submoniliform, segment 2 subequal to or a little shorter than segment 3.

Pronotum subcordate; sides bordered and more or less reflexed, both lateral and postangular setae present; front angles produced forwards, hind angles rectangular or sharp; median line distinct, not reaching both apical and basal borders, basal foveae and basal sulcus deep, impunctate.

Elytra elongate, border angulate at shoulder and extending inwards to stria 5 or a little beyond it; striae all distinct, impunctate; interval 3 with two dorsal pores close to or nearly adjoining stria 3, apical pores adjoining apical striole which merges anteriorly into stria 5; series of umbilicate pores 4+2+2, posthumeral group nearly regular.

Ventral surface impunctate and without pubescence; metasternal process not bordered; anal sternite with two setae on each side in the two sexes.

Legs stout; protarsi with proximal two segments dilated, inwardly produced at apices and furnished beneath with sexual adhesive hairs in ♂.

Male genital organ well chitinized. Aedeagus elongate, twisted with apex strongly bending to right side; basal orifice widely open to right face, right basal lobe produced; apex widely rounded; copulatory pieces small, consisted of the bundles of fibres and bristles. Styles unequal in length, left style more or less longer than right one, each provided with one or two setae at apex.

The species belonging to this genus are usually of marine dwellers and inhabit the intertidal zone on the Pacific coast.

Key to the subgenera

1 (2) Metatrochanters long, about two-thirds as long as metafemora, and tapering to an acute point at the extremity; metathoracic wings present; side-gutter of pronotum becoming shallower in front, elytral striae 6 and 7 normal; styles each with two apical setae... ..... *Novicillenus* nov.

2 (1) Metatrochanters normal, less than a half as long as metafemora, and each rounded at apex.

3 (4) Metathoracic wings present; elytral striae 6 and 7 normal, not abbreviated, side-gutter of pronotum becoming shallower in front; styles each with a single apical seta .... *Desarmatocillenus* NETOLITZKY.

4 (3) Metathoracic wings atrophied; elytral striae 6 and 7 interrupted at about middle, interval 5 widening out from there and forming outside a remarkable carina, which is composed of the merging apical half of intervals 6, 7 and 8; sides of pronotum so strongly reflexed throughout that side-gutter on each side deep even in front; styles each with two apical setae ..... *Coralicillenus* nov.

Armatocillenus (*Novicillenus* nov.) *aestuarii* S. UÉNO et HABU, sp. nov.

(Figs. 9–10)

Length: 3.9—4.7 mm (from front margin of clypeus to anal end).

Winged. Body elongate. Shiny black with brownish fundamental tone, head

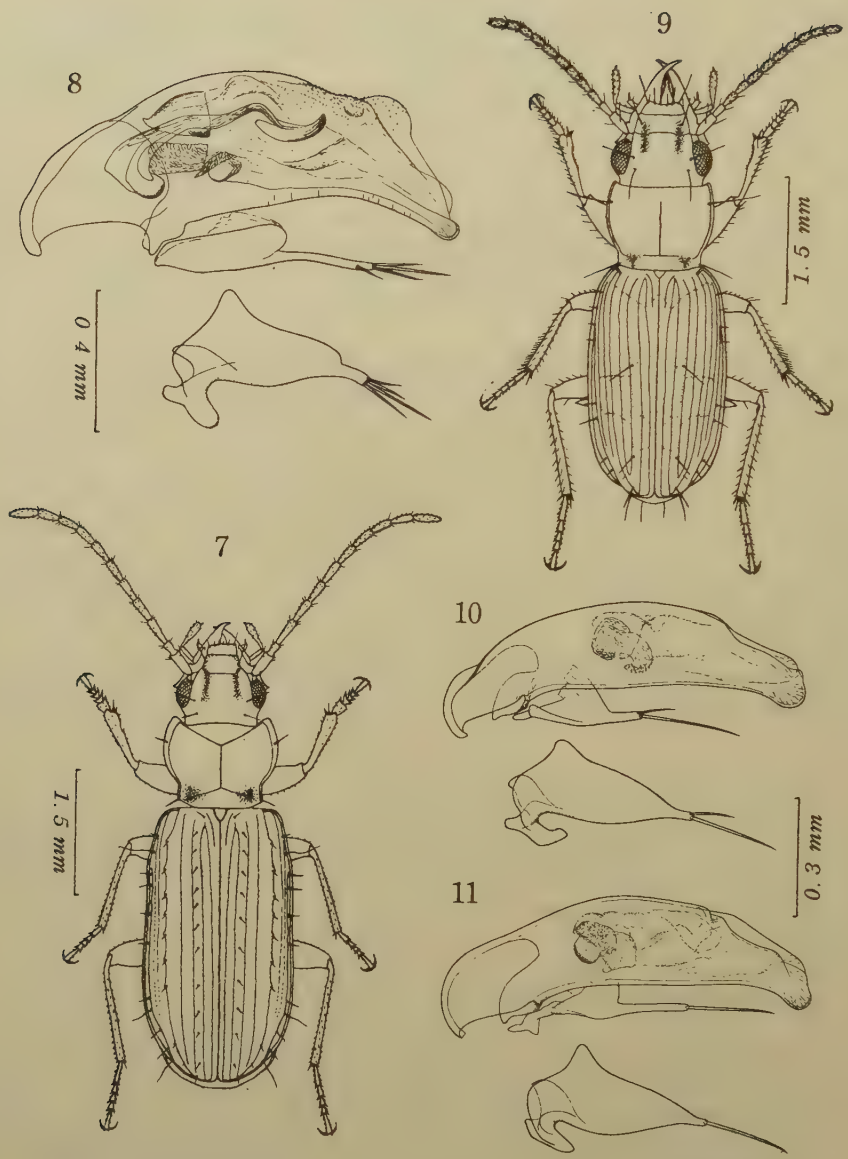

Fig. 7. *Sakagutia marina* S. UÉNO, gen. et sp. nov., ♂ of Sakai-Minato.
Fig. 8. Male genital organ of same species, left lateral view, with left style removed.
Fig. 9. *Armatocillenus aestuarii* S. UÉNO et HABU, sp. nov., ♀, of the Shin-Yodogawa River.
Fig. 10. Male genital organ of same species, left lateral view, with left style removed.
Fig. 11. Male genital organ of *Armatocillenus yokohamae* (H. W. BATES), of the Shin-Yodogawa River; left lateral view, with left style removed.

and pronotum with strong aeneous tinge, sternites, especially median areas brownish; propleura and elytra brownish yellow with very weak olivaceous tinge, the latter with dark patterns more or less well developed; these patterns on elytra vary in shape and extent according to individuals: in lighter individuals, they are reduced to three parts, *viz.* basal area, small spot surrounding front dorsal pore, and a somewhat comma-shaped spot lying obliquely at apical one-third on each elytron, while, in darker ones, apical comma-shaped spot on each elytron extends inwardly and approaches as to form a large rhomboidal spot on suture; clypeus and mandibles dark brown; palpi, proximal four segments of antennae (rest fuscous), and legs pale brownish yellow.

Head very large and wide, surface flat, with wide and parallel frontal furrows extending onto clypeus; eyes prominent, genae indistinct; neck very wide, not constricted; labrum short and transverse, frequently asymmetric; well developed isodiametric microsculpture present on whole surface; mandibles remarkably long, stout, hooked at apices; antennae subfiliform, rather short, extending a little beyond the base of elytra, apical segments ovaler than proximal ones.

Pronotum transverse subcordate, contracted behind, moderately convex; a little wider than head, about 1.3 times wider than long, widest at about apical one-fourth; sides slightly rounded in front, moderately sinuate behind, lateral seta inserted at about apical one-fifth; front angles projected forwards though rounded at the extremities, hind angles nearly rectanglar or a little obtuse according to individuals; base distinctly narrower than apex, obliquely and slightly emarginate on each side; median line distinct, front transverse impression shallow, basal transverse sulcus deep, basal foveae large and deep; microsculpture consisted of well marked isodiametric meshes, which are rather faint on disk.

Elytra elongate, convex, about 1.3 times wider than pronotum, about 1.8 times longer than wide; sides nearly parallel or slightly rounded according to individuals, slightly emarginate before apex, posthumeral border oblique; striae deep, impunctate, outer striae deeper than inner ones; intervals slightly convex or rather flat near suture, well convex near sides; interval 3 with two dorsal pores close to stria 3 at about three-sevenths and four-fifths from base respectively; microsculpture constructed by well marked isodiametric meshes.

Apices of metatrochanters visible from above.

Aedeagus elongate, bending ventrally before apex which is widely rounded; ventral side slightly covex before middle. Left style evidently longer than right.

Holotype: ♂, allotype: ♀, the Shin-Yodogawa River by Jûsô in Osaka, Honshu, 9—V—1949, collected by S. Uéno.

Paratypes: 1 ♂, 3 ♀♀, the Shin-Yodogawa River by Tsukamoto in Osaka, 5—VII—1945, by S. Uéno; 7 ♂♂, 14 ♀♀, the Shin-Yodogawa River by Jûsô in Osaka, 5—VI—1947, by S. Uéno; 1 ♂, from the same locality, 9—V—1949, by S. Uéno; 1 ♀, Fukuoka, Kyushu, 11—VI—1953, by Y. Murakami.

The type-specimens are deposited in the collections of S. UÉNO and A. HABU,

This is a remarkable new species which seems to the writers to be allied to *A. albertisi* (PUTZEYS) known from New Guinea (ANDREWES, 1938, p. 192), but may by distinguishable at first sight by the coloration.

In the Shin-Yodogawa River it dwells below the high-water mark near the estuary, associated with *Armatocillenus yokohamae*, *Peryphus semiluitus* and *P. aureofuscus*. When the tide is on the flow, they seek shelter under stones or in the hollows of other invertebrate animals, or burrow the sand, and rest till the next ebb. A specimen from Fukuoka was caught at a light-trap.

Armatocillenus (*Desarmatocillenus*) *yokohamae* (H. W. BATES)

(Fig. 11)

Cillenus yokohamae H. W. BATES, 1883, Trans. Ent. Soc. London, 268; type-locality: Kawasaki, near Yokohama.
Bembidion (*Cillenus*) *yokohamae*, ANDREWES, 1938, Proc. R. Ent. Soc. London, (B), **7**: 193.
Bembidion (*Desarmatocillenus*) *yokohamae*, NETOLITZKY, 1942, Koleopt. Rdsch., **28**: 39, 68.
Bembidion yokohamae, HABU, 1950, Iconog. Ins. Jap., ed. 2, 964, fig. 2744.

The excellent redescriptions of this interesting species have been given by ANDREWES and HABU, but the structure of its male genital organ must be added.

Aedeagus similar in structure to that of *A. aestuarii*, but relatively a little more elongate, with apex rather narrowly rounded and bending more strongly. Right style comparatively long, though obviously shorter than left, with long apical prolongation.

This species spreads over the Pacific coast of southern Japan and inhabits the intertidal zone, especially of sandy beaches of brackish water areas. It is often obtained at estuaries, where it feeds upon small larvae of flies or, perhaps, larvae of the other beetles which are found in the same habitat.

The writer has examined the specimens from the following localities:

Honshu: the estuary of the Arakawa River, Tokyo; Hiratsuka, Kanagawa Pref.; the Setogawa River and Numazu, Shizuoka Pref.; the Shin-Yodogawa River and Hamadera, Osaka.

Shikoku: the estuary of the Yoshinogawa River, Tokushima Pref.; the estuary of the Niyodogawa River, Kôchi Pref.

Kyushu: Saéki, Ôita Pref.

The male genital organ was examined in the specimens from the Shin-Yodogawa, the Niyodogawa and Saéki.

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INVERTEBRATE FAUNA OF THE INTERTIDAL ZONE OF THE TOKARA ISLANDS

XI. HYDROIDA[1]

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With Plates XXIII–XXIV

The following is a report on the hydroids obtained by the Tokara Scientific Research Party of the Osaka Municipal Museum of Natural History in June and July of 1953. The materials were collected by Dr. T. TOKIOKA of the Seto Marine Biological Laboratory, who took part in the expedition, from the intertidal zone of Takarazima and Nakanosima in the Tokara Islands which range between Kyushu and the Ryukyu Islands in the southern Japanese water. These were submitted to the writer for identification through the courtesy of Dr. T. TOKIOKA.

The materials were composed of 4 vials, of which one from Takarazima and other 3 from Nakanosima. Two vials were filled with formalin solution, while other two were entirely dried up. Six species in 6 genera and 2 families are represented, among them one species can not be securely identified because the specimen is poorly preserved.

The species here treated are as follows:

Sertularidae
Dynamena tubuliformis MARKTANNER-TURNERETSCHER
Sertularia distans (LAMOUROUX)
Plumularidae
Monotheca obliqua (THOMPSON)
Plumularia setacea (LINNÉ)
Heterotheca sp.
Aglaophenia amoyensis HARGITT

Of the species mentioned above, the former 4 are the previously known species from middle Japanese water but the last one, *Aglaophenia amoyensis*, has heretofore been recorded only through its original discovery, from Amoy, South China.

1) Scientific Survey of the Tokara Islands, Report No. 14.

Concerning the hydroid fauna of the southern Japanese water references are very scarce, and we have only the paper of JÄDERHOLM (1919) which dealt with the specimens from Kyushu and the Goto Islands. So this report seems to be an interesting one, though the collection is neither rich in species nor in individuals.

The writer wishes to thank Dr. T. TOKIOKA for the privilege of examining this collection, and Dr. H. HATTORI for his kind suggestions and for supplying the specimens of *Heterotheca* preserved at the Biological Laboratory of the Imperial Palace for comparison. Thanks are also due to Prof. T. UCHIDA, under whose guidance this study was carried out.

Dynamena tubuliformis MARKTANNER-TURNERETSCHER

(Pl. XXIII, Figs. 1, 2)

Sertularia tubuliformis: JÄDERHOLM, 1919, p. 15.
Dynamena tubuliformis: STECHOW, 1923, p. 12.
Thuiaria tubuliformis: HARGITT, 1924, p. 493, pl. 4, fig. 16; ——, 1927, p. 508, pl. 1, figs. 4, 5.

Several specimens without gonosomes were collected at Takarazima and Nakanosima and were preserved in formalin solution.

The colony attains about 27 mm in height in the largest specimen examined. The stem is almost straight throughout, irregularly and sparingly branched, but sometimes nearly alternate branching gives the colony a geniculate aspect. The branch gives off at an angle of 40° to 50° with the stem, but no particular difference is present in the appearance of a branch and a main stem. The stem and branches are divided into irregular internodes which are rather short and usually bear one or two pairs of the hydrothecae. The node is usually quite sharply marked but is often not well marked. The hydrothecae are slender, not closely placed on stem and branches, usually in nearly opposite pairs. These are rather long tubular in shape, and deeply immersed into the stem near the base but less so on the other part of stem and branches. The distal part of the hydrotheca is slightly narrowing toward the margin, about one-third of adcauline wall free, and abruptly turned outward ending in large blunt paired teeth which support a two-flapped operculum. The abcauline wall of the hydrotheca measures 0.40–0.45 mm in length, and the breadth at the widest part 0.19 mm and at the margin 0.15 mm.

The gonosomes are absent.

As the hydranths of this specimens show no abcauline blind-sack, I include here the species in the genus *Dynamena*. This specimens closely agree with those described by HARGITT from South China and the Philippine Islands. The species has been reported by JÄDERHOLM from Misaki and the Bonin Islands but was not contained in INABA's and STECHOW's works. It may be mentioned here I have recently examined the species among the specimens from Seto. The specimens from Misaki, the Bonin

Islands, the Philippine Islands and Seto were all devoid of gonosomes while the only one from Amoy, South China bore gonosomes.

Besides the above localities it has been recorded from the Red Sea, from the Natal coast of South Africa, and from the coast of Florida, the West Indies and the coast of Brazil, in the Atlantic.

Sertularia distans (Lamouroux)

(Pl. XXIII, Fig. 3)

Sertularia sp.: Inaba, 1890, figs. 60–62.
Sertularia distans: Stechow, 1913, p. 147, fig. 125; Jäderholm, 1919, p. 14, pl. 3, fig. 7; Leloup, 1938, p. 17.
Dynamena distans: Stechow, 1923, p. 12.

Some small specimens without gonosomes were collected at Nakanosima and were all dried up.

The colony is in the form of an erect stem, unbranched, delicate, attaining about 8 mm in height. The stem is not fascicled, straight throughout, divided into regular internodes, each of which bears a pair of strictly opposite hydrothecae. The hydrothecae in a pair are in contact with each other in about a half of the adcauline wall. They are rather distinct, tubular in shape, not elongate, moderately swollen below. The margin of the hydrotheca has blunt paired teeth which support a two-flapped operculum. The abcauline wall of the hydrotheca measures 0.19–0.22 mm in length, and the breadth at the widest part 0.15 mm and at the margin 0.09 mm.

The gonosomes are absent.

This species has been recorded from middle Japan. Inaba reported the species from Misaki and Jäderholm from the Bonin Islands and Misaki. Recently Leloup recorded the species from the northern part of Sagami Bay.

The species is distributed in western coast of the Pacific, and the Atlantic and the Mediterranean.

Monotheca obliqua (Thompson)

(Pl. XXIII, Fig. 4)

Plumularia obliqua: Jäderholm, 1919, p. 22, pl. 5, fig. 6.
Monotheca obliqua: Stechow, 1923, p. 17.
Plumularia (*Monotheca*) *obliqua*: Stechow and Uchida, 1931, p. 565.

Some small colonies without gonosomes were collected at Nakanosima and were all dried up.

The colony is small, very delicate, attaining about 8 mm in height, growing on sea-weeds. The stem is not fascicled, mostly erect, unbranched, divided into regular internodes, each of which gives off a hydrocladium from a process at its distal end. The hydrocladia are alternately present, lying in the same plane, short, with two

small joints at the base. Each of the hydrocladia bears a single hydrotheca. The hydrothecae are campanulate, with an entire margin. There are two namatophores on each internode of the stem, one on just below the middle of the internode and one on the axil of each hydrocladium. On each hydrocladium three nematophores are present, two of which supracalycine and one mesial at the base of the hydrotheca. The hydrocladia measure about 0.32 mm in length.

The gonosomes are not found.

The species is one of the common species in Japanese water. Although the species was not contained in INABA's and STECHOW's works, JÄDERHOLM (1919) reported it covering sea-weeds from Misaki. Afterwards the species was described from Mutsu Bay by STECHOW and UCHIDA (1931).

The species is distributed in Japan, Australia, the Mediterranean and England.

Plumularia setacea (LINNÉ)

(Pl. XXIV, Figs. 1, 2)

Plumularia setacea: INABA, 1890, figs. 8-10; STECHOW, 1909, p. 79; ——, 1913, p. 89; JÄDERHOLM, 1919, p. 20; STECHOW, 1923, p. 17.

Some small colonies which were all dried up were collected at Nakanosima.

The colonies are very delicate, reaching about 9 mm in height. The stem is simple, slightly flexuous, unbranched, divided into regular internodes, each bearing a hydrocladium. The hydrocladia are regularly alternate, present in the same plane, rather short, originating immediately below the joint of the stem. The hydrocladia are composed of longer and shorter internodes, which are alternately placed: the longer internodes are thecate ones and the shorter are non-thecate ones. At the base of each hydrocladium there are always 2 or 3 small joints which bear no hydrothecae. The hydrothecae are small, with an entire margin, rather distant. There are two supracalycine nematophores and a mesial nematophore to each hydrocladial internode, except for the basal part. There are two nematophores on each internode of the stem, one on the side opposite the hydrocladial process and one in the axil of each hydrocladium.

The gonosomes are not found.

The species has been reported by INABA (1890) and STECHOW (1909, 1913) from Sagami Bay and by JÄDERHOLM (1919) from Sagami Bay and the Goto Islands. The species has almost cosmopolitan distribution, although it seems to be absent from the Arctic and Antarctic regions.

Heterotheca sp.

(Plate XXIV, Figs. 3, 4)

A few fragmentary specimens in dried state were found in Nakanosima, cövering

sea-weeds. The form was considerably damaged for the drying, so detailed survey on its morphology was impossible. The trophosome, so far as I could understand from the present specimens, is as follows:

The colony is plumose in shape, attaining about 7 mm in height. The stem is divided into regular internodes, each of which bears a hydrotheca and a pair of supracalycine, a pair of lateral and one mesial nematophores, and a hydrocladium at the distal end. The hydrocladia are alternate, not in the same plane, divided into regular internodes, each of which bears a hydrotheca and 5 nematophores as in the stem internode. The hydrothecae are approximately present; the margin bears a pair of blunt shoulders. The supracalycine namatophores are small but the lateral ones are very long surpassing the hydrothecal margin. The mesial nematophores are small and unmovable.

The gonosomes are not found.

Although the specimens are mostly in poor condition as above stated, these may be referred to the genus *Heterotheca*, which was created by STECHOW (1921). This genus is characterized for having unmovable mesial nematophores and cauline hydrothecae. Recently I have had an opportunity to examine specimens which were collected in southern Kyushu and preserved at the Biological Laboratory of the Imperial Palace, and were referred to *Heterotheca polymorphus* var. *sibogae* (BILLARD) and *H. campanula* (BUSK). These are, however, clearly distinguished from the present species. Although the species seems to me probable to be a new species of *Heterotheca*, I can make no further mention here at the present state.

Aglaophenia amoyensis HARGITT

(Plate XXIV, Figs. 5, 6)

Aglaophenia amoyensis: HARGITT, 1927, p. 517, pl. 1, fig. 3.

Several colonies were collected at Nakanosima.

The colonies are small, plumose in shape, attaining 7 mm in height. The stem is unbranched, not fascicled, divided into regular internodes, each of which supports a hydrocladium on a process near its distal end. The hydrocladia are alternate, not in the same plane, rather short, divided into regular short internodes, each of which bears a hydrotheca. The hydrothecae are closely approximated, having about 8 rather acute teeth around the margin. The intrathecal ridge is short and thin. The mesial nematophore is extensively adnate to the hydrotheca, only the terminal portion being free and reaching just below the margin of the hydrotheca. The supracalycine namatophores slightly overtopping the hydrothecal margin. In each internode of the stem a cauline nematophore is present.

The gonosomes are not found.

This is the second report of the species since the original description of HARGITT (1927) from Amoy, South China. The specimens from Amoy were found among

sponges and bryozoans, and on a dead stem of an alcyonarian, while the present specimens are found to cover sea-weeds. The present specimens closely agree with the description of HARGITT.

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EXPLANATION OF PLATES XXIII–XXIV

PLATE XXIII

Fig. 1. *Dynamena tubuliformis* MARKTANNER-TURNERETSCHER. Portion of stem and branches. × 25

Fig. 2. *Dynamena tubuliformis* MARKTANNER-TURNERETSCHER. Portion of branch showing hydrothecae. × 35

Fig. 3. *Sertularia distans* (LAMOUROUX). Portion of colony with hydrothecae. × 50

Fig. 4. *Monotheca oblique* (THOMPSON). Portion of stem with hydrocladia and hydrothecae. × 75

PLATE XXIV

Fig. 1. *Plumularia setacea* (L.). Portion of stem. × 75

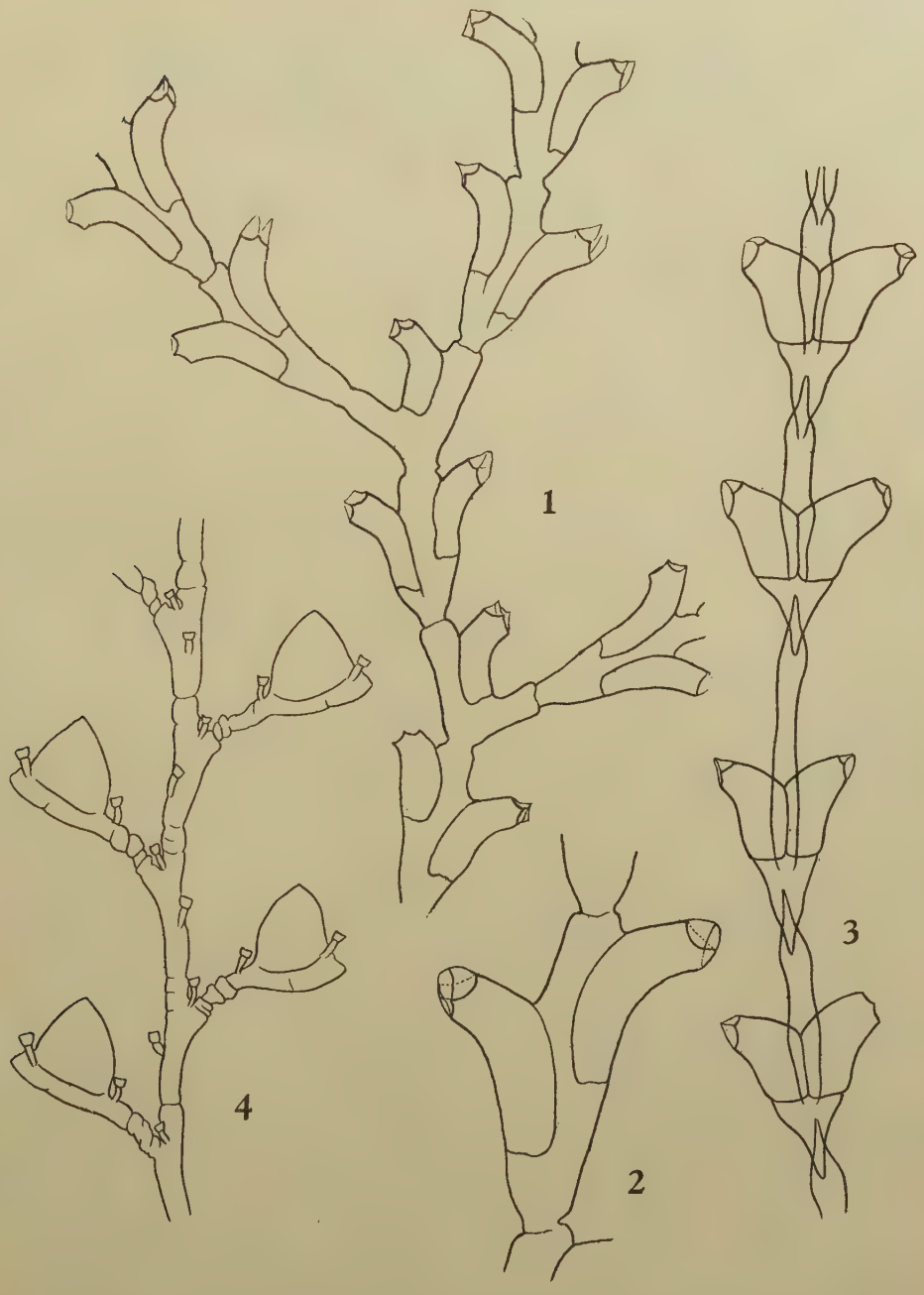
Fig. 2. *Plumularia setacea* (L.). Portion of stem and hydrocladium. × 75

Fig. 3. *Heterotheca* sp. Portion of stem with hydrocladia and hydrothecae. × 75

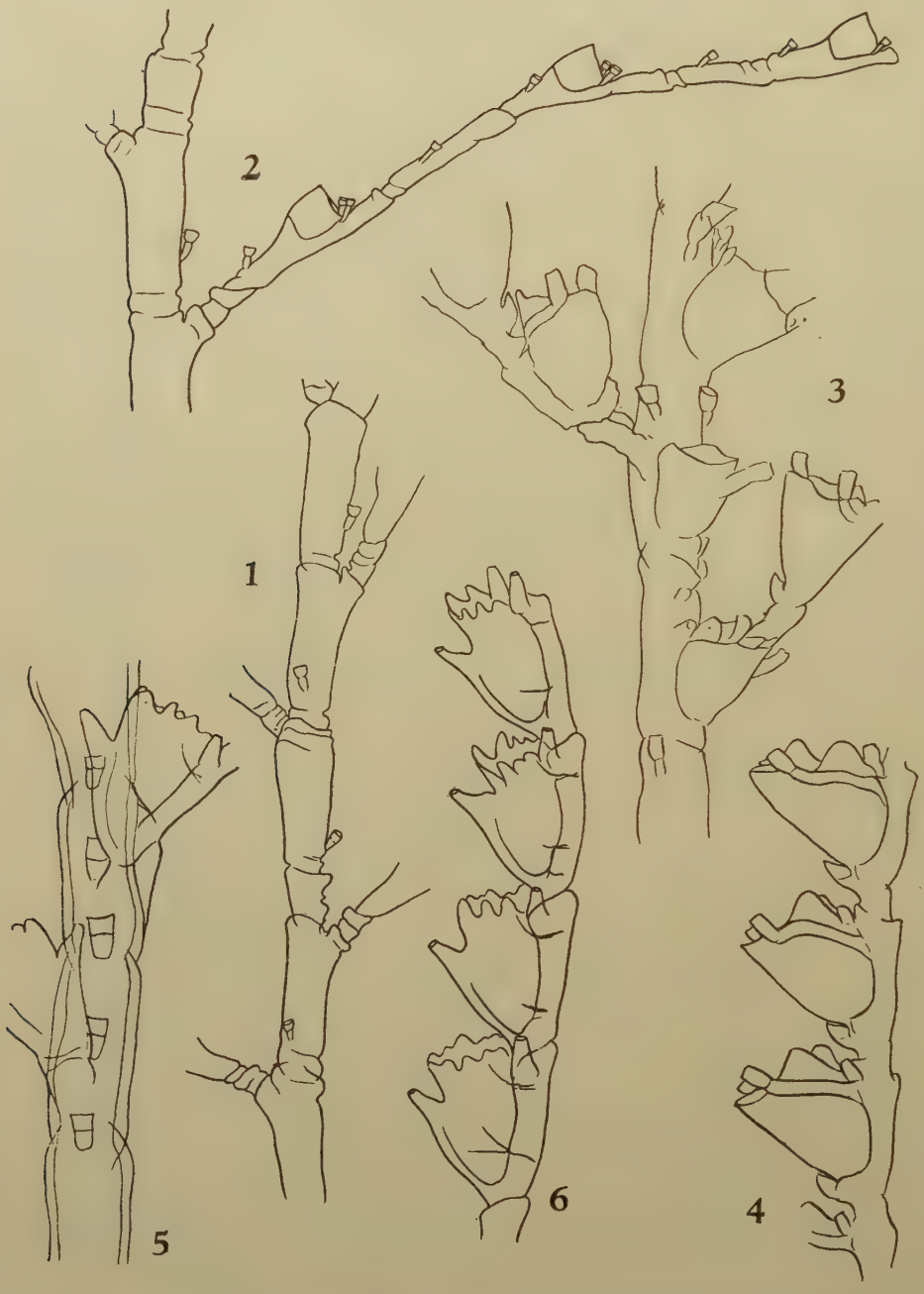
Fig. 4. *Heterotheca* sp. Portion of hydrocladium. × 75

Fig. 5. *Aglaophenia amoyensis* HARGITT. Portion of stem. × 75

Fig. 6. *Aglaophenia amoyensis* HARGITT. Portion of hydrocladium. × 75



M. YAMADA: INVERTEBRATE FAUNA OF THE TOKARA ISLANDS, XI.



M. YAMADA: INVERTEBRATE FAUNA OF THE TOKARA ISLANDS, XI.

MARINE INSECTS OF THE TOKARA ISLANDS

I. MARINE CRANEFLIES (DIPTERA, TIPULIDAE)[1)2)]

Akira NOBUCHI

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With 3 Text-figures

The present study was undertaken under the direction of Prof. Dr. Masaaki Tokunaga on the materials collected by Messrs. Syôiti Miyamoto, Takehiko Nakane and Shun-ichi Uéno at the coral reef and rocky shore of the islands.

There have hitherto been known 18 species of marine Tipulids, including 4 Japanese species of *Idioglochina* and *Dicranomyia* respectively. The marine craneflies from the Tokara Islands are identified with *Limonia* (*Idioglochina*) *tokunagai* Alexander and *Limonia* (*Dicranomyia*) *tokara* n. sp. Thus, at present I intend to report a new marine cranefly with its description.

I express my cordial thanks to Prof. Dr. Masaaki Tokunaga and Mr. Mitsuhiro Sasakawa of Saikyo University, for their useful suggestions on this investigation. I am also indebted to Messrs. Syôiti Miyamoto, Takehiko Nakane and Shun-ichi Uéno, members of the Tokara Expedition, for their kindness in collecting the materials. Further, I wish to express my thanks to Miss Etsuko Kōmyō for her kind help given on this study.

1. *Limonia* (*Idioglochina*) *tokunagai* Alexander

1932. Philipp. Jour. Sci., 49: 113–115.

A male specimen; Nakanoshima Island, Tokara Islands; June 10, 1953; Shun-ichi Uéno leg. A male and a female; June 10, 1953; Syôiti Miyamoto leg.

Distribution:—Kii Peninsula, Okinoshima, Danzyo Islands (Kyushu) and Nakanoshima Island.

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1) Scientific Survey of the Tokara Islands, Report No. 15.

2) Contributions from the Entomological Laboratory, Saikyo University, Kyoto, No. 23.

2. *Limonia* (*Dicranomyia*) *tokara* sp. nov.

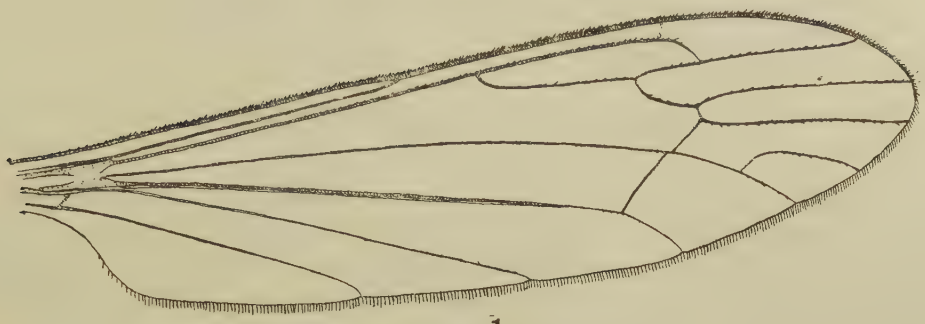
Male:—Body length about 4.5 mm; general coloration of body dirty yellow; mouth-parts and antennae yellowish brown; eyes entirely black; mesopraescutum with longitudinal stripe broadly brown on central part; thoracic notum with lateral brownish stripes extending from middle of mesopraescutum to caudal margin of mesoscutum; pleural side with a dark brown distinct stripe extending from cervical sclerites, through beneath wing and halter, to seventh abdominal segment; abdominal tergites brown and sternites dirty yellow, but in some paratopotypical specimens tergites and sternites brown and with a pale band on caudal margin of each segment.

Head thinly covered with setae; eyes bare; antennae 14-segmented; flagellar segment almost oval, with about five setae; ultimate segment (Fig. 2) slightly smaller than penultimate (1 : 1.2). Maxillary palpi relatively short. Wings (Fig. 1) about 5.5 mm in length, pale brown and hyaline, stigmal area not clouded; veins brown. Venation: Sc_1 ending before origin of Rs, Sc_2 lacking, m-cu before or at fork of M, median cell opened cross vein being atrophied, Cu_2 closely extending beneath Cu_1. Halteres yellowish white. Legs brown; coxae, trochanters and basal half of femora paler, proportional lengths of segments of legs, excepting two proximal segments, as follows: 5.3 : 6.8 : 4.45 : 1.5 : 0.6 : 0.3 : 0.3 in fore, 6.2 : 6.6 : 3.3 : 1.45 : 0.7 : 0.3 : 0.3 in middle, and 7.0 : 7.6 : 3.6 : 1.5 : 0.75 : 0.35 : 0.5 in hind leg (1.7 units=1 mm); third and fourth tarsal segments of all legs with a row of apical setae on apical half of ventral side. Claws rather strongly bent at middle and with a long basal tooth. Abdominal octatergum narrow, not subdivided; novatergum with marginal setae on lateral and caudal sides, inverted trapezoid, its caudal margin being shorter than cephalic margin; its caudal margin slightly concave and with a small blunt projection at center. Hypopygium (Fig. 3) with chitinized parts brown; coxite elongate, with setae relatively sparse; ventral lobe of coxite rather broad; style bare, strongly curved at distal part; ventral style with rostral projection which is setigerous apically and provided with a black stout needle-like process; aedeagus comparatively slender.

Female:—Body about 5.5 mm. long, similar in coloration to male, excepting dark brown abdomen. Wings about 5.3 mm long. Proportional lengths of segments of legs as follows: 4.2 : 5.3 : 2.95 : 0.95 : 0.43 : 0.3 : 0.35 in fore, 5.6 : 5.45 : 2.35 : 1.05 : 0.5 : 0.35 : 0.35 in middle, 6.2 : 6.15 : 2.9 : 1.15 : 0.5 : 0.3 : 0.3 in hind leg (1.7 units=1 mm); apical three tarsal segments of all legs with a row of special setae on ventral side; claws comparatively small, with three basal teeth. Hypopygium cerci longer than twice of basal width (2.2 : 1), octavalvae short, but longer than their basal width (1.5 : 1).

Habitat:—Tidal zone of the Pacific coast, Ryukyu, Japan.

Holotype:—Male; Nakanoshima Island, Tokara Islands; June 10, 1953; Takehiko NAKANE leg.



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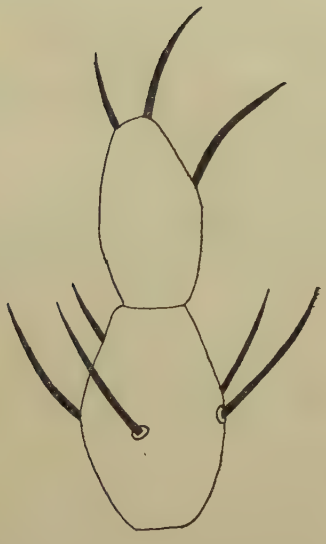

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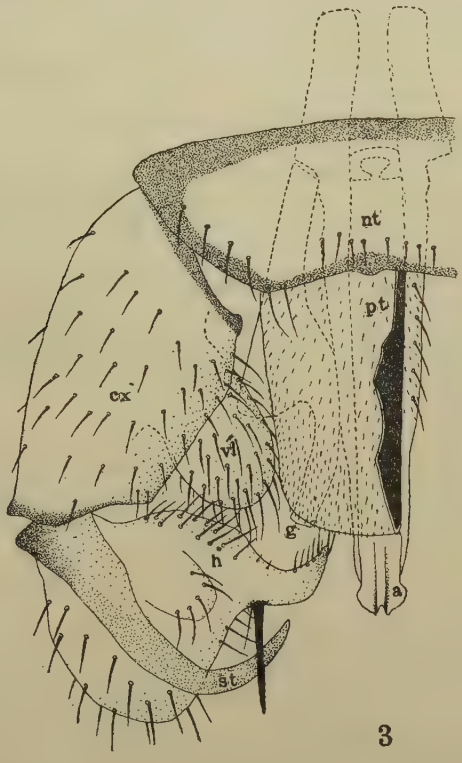

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Limonia (*Dicranomyia*) *tokara* n. sp.

Fig. 1. Male wing.
Fig. 2. Ultimate two segments of male antenna.
Fig. 3. Male hypopygium, dorsal aspect.

Allotopotype:—Female; June 10, 1953; Takehiko NAKANE leg.

Paratopotypes:—72 males and 7 females; June 10, 1953; Takehiko NAKANE leg. 4 males; June 10, 1953; Shun-ichi UÉNO leg, together with *Limonia* (*Idioglochina*) *tokunagai* ALEXANDER.

Type specimens:—Alcoholic; deposited in the Entomological Laboratory of Saikyo University.

This new marine cranefly is related to *Limonia* (*Dicranomyia*) *halobia* TOKUNAGA (Amakusa Islands, Japan), but differs from that in the following characters: dark brown stripe of thorax and abdomen, relative size of two distal segments of antenna, specific shape of abdominal tergite of male hypopygium and a strong needle-like process of ventral style of male which is not a seta nor bristle.

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MARINE INSECTS OF THE TOKARA ISLANDS

II. MARINE MIDGES (DIPTERA, CHIRONOMIDAE)[1) 2)]

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With 5 Text-figures

The present paper deals with marine or seashore midges collected by Messrs. S. Miyamoto, T. Nakane and S. Uéno, members of the survey of the Tokara Islands, from the tidal zone of a rocky seashore and coral reef at Nakanoshima. These midges are identified as follows:

Chironomidae (=Tendipedidae)

Clunioninae

1. *Clunio setoensis* Tokunaga (1933)
2. *Telmatogeton pacificus* Tokunaga (1935)
3. *Thalassomyia japonica* Tokunaga et Etsuko K. (n. sp.)

From Japan, hitherto, there have been known only two genera of Clunioninae, *Clunio* Haliday and *Telmatogeton* Schiner. The discovery of the genus *Thalassomyia* Schiner at the Tokara Islands is the first record in Japan. We intend, at present, to report this discovery with a description of a new species of the genus.

We wish to express our hearty thanks to Messrs. S. Miyamoto, T. Nakane and S. Uéno for their kindness in collecting these small midges which are difficult to collect.

1. *Clunio setoensis* Tokunaga

This species has been reported by Tokunaga (1933–1935) from the Pacific coast of Japan and the Ishigaki Islands. At this time, many males and nine females were collected at the rocky coral reef of the Tokara Islands.

Specimens:— Alcoholic males and females, Nakanoshima, Tokara Islands, Ryukyu, Japan; May 28 and June 12, 1953; collected by Messrs. S. Miyamoto and S. Uéno; deposited in the Entomological Laboratory of Saikyo University.

1) Scientific Survey of the Tokara Islands, Report No. 16.

2) Contributions from the Entomological Laboratory, Saikyo University, Kyoto, No. 24.

2. *Telmatogeton pacificus* TOKUNAGA

This species has been reported by TOKUNAGA (1935 and 1937) from Japan and by WIRTH (1947) from the Hawaiian Islands.

The midges collected at the Tokara Islands are smaller, being about 2 mm in body length and the development of the body setae are more slight than in the original description. The antennae of some specimens are 6-segmented. The reduction of the antennal segments of this species is not rare and has been studied in detail by TOKUNAGA and YOSHIMURA (1935).

Specimens:— Alcoholic males; Nakanoshima, Tokara Islands, Ryukyu, Japan; June 10, 1953; collected by Mr. S. UÉNO; deposited in the Entomological Laboratory of Saikyo University.

3. *Thalassomyia japonica* TOKUNAGA et ETSUKO K. (sp. nov.)

(Figs. 1–5)

Male:— Body length about 3.5–3.8 mm; general color yellowish brown; scutellum and legs brown; abdomen brownish grey, its ventral side paler; wings smoky brown; halters white.

Antennae (Fig. 1) 7-segmented; each flagellar segment with four strong setae; distal segment with a terminal papilliform projection; ratio of segments about 27 : 32 : 15 : 15 : 13 : 13 : 33. Palpi long, 4-segmented, with setae dense on second segment, sparse on other segments and quite sparse on fourth. Paraglossa ovoid and bristly, slightly smaller than second palpal segment. Clypeus covered with dense and long bristles; vertex covered with bristles.

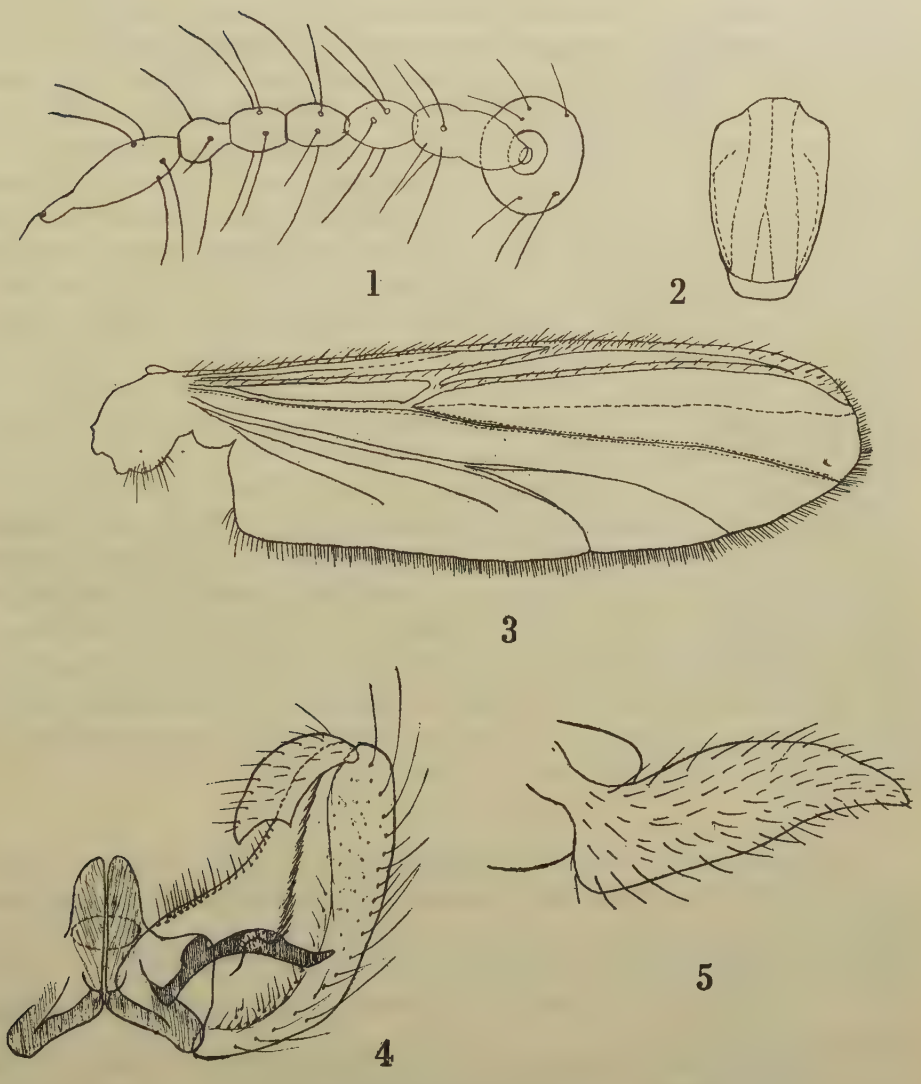
Pronotum very narrowly separated at middle and each lateral lobe narrow, with about fourteen setae. Mesonotal setae in pattern as in Fig. 2; scutellum with about twenty-six setae; postscutellum bare.

Wings (Fig. 3) about 3 mm long and 0.7–1 mm wide, covered with microtrichia, appearing smoky brown; veins brown. Costa, R, R_1 and R_s densely set with strong dark brown setae; other veins without setae; squama fringed with hairs and alula bare. Venation: R_1 about a quarter of R_s, R_s evenly curved at distal part, cross-vein r-m far before the middle of wing, medio-cutital fork distinctly beyond r-m, Cu_1 strongly curved at distal part.

Legs long, densely setigerous with short setae; longest of those setae shorter than twice of diameter of segment; ratio of segments as follows:

Fore ……35.5 : 41 : 23 : 9 : 5 : 2 : 4
Middle…50 : 48 : 20.5 : 7 : 4.7 : 2 : 4
Hind……51 : 55 : 31.5 : 14 : 9 : 2.2 : 4

Femora thickened basally; tibiae slender; tarsal segments cylindrical, except for fourth segment, which is short and obcordate; last tarsal segment simple; empodium long



Thalassomyia japonica sp. nov.

Fig. 1. Male antenna.
Fig. 2. Setae arrangement of mesoscutum.
Fig. 3. Male wing.
Fig. 4. Male genitalia.
Fig. 5. Female cercus.

and thinly plumose; claws slender and simple, but anterior claw of fore and middle legs are pectinate at tip; pulvilli arise from base of each claw as hyaline, almost as long as claw.

Abdomen moderately setigerous with delicate setae. Male genitalia (Fig. 4) inverted, somewhat similar to that of *T. bureni* Wirth, except for the shape of the dististyle, which is specific in shape, being somewhat rhombic, extensor edge round and flexor edge angulated; basistyle with a row of very strong bristles along mesal edge of sternal side and a small blunt tubercle on basal part of tergal side.

Female:— Body length about 3.5–3.8 mm; generally as in male, usually stouter than male. Abdomen stout, taper at caudal part. Cerci (Fig. 5) elongate, about four times long as basal width, setigerous with minute setae, slightly curved downwards at tip; subgenital plate setigerous on distal part; with U-shaped median incision on caudal margin; lateral side of genital segment without distinct setigerous patch. Claws of all legs simple. Wings about 3.8 mm long, 0.7 mm wide.

Habitat:— Tidal zone of rocky shore and coral reef, Pacific coast, Japan.

Holotype:— Male; Nakanoshima, Tokara Islands, Ryukyu, Japan; June 10, 1953.

Allotopotype:— Female; June 10, 1953.

Paratopotypes:— Many males and females; June 3 and 10, 1953.

Type specimens:— Alcoholic and dry; deposited in the Entomological Laboratory of Saikyo University; collected by Messrs. S. Miyamoto, T. Nakane and S. Uéno.

This species is very closely allied to *T. bureni* Wirth, but distinctly specific in the following points: the arrangement of the setae on the mesonotum is rather similar to that of *T. maritima* Wirth, the wings are not provided with setae on base of M, Cu and 1A, the longest setae of the legs are shorter than twice of diameter of the segment, the abdomen of both sexes is not laterally compressed, and the dististyle of the male genitalia is somewhat rhombic in sternal aspect.

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MARINE INSECTS OF THE TOKARA ISLANDS

III. A NEW SPECIES OF *NOCTICANACE* FROM JAPAN (DIPTERA, CANACEIDAE)[1)2)]

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With 2 Text-figures

The Canaceidae is a small family including about 32 species, but it is widely distributed in the world and almost exclusively intertidal in habitat, excepting two fresh water species: *Procanace nigroviridis* CRESSON from the Hawaiian Islands and *P. opaca* DE MEIJERE from Java. Nothing has been hitherto reported concerning Japanese Canaceids. In the present paper, I intend to report as a first record a new species of *Nocticanace*, which was collected by Mr. S. UÉNO from a rocky coral reef of the Tokara Islands, Ryukyu. This study was undertaken under the direction of Prof. Dr. Masaaki TOKUNAGA, to whom I am very grateful for his kind guidance. I am also indebted to Mr. Shun-ichi UÉNO for his kind collection which made this study possible.

Nocticanace pacificus sp. nov.

Male and female:—Body about 1⅔ mm long, dull black; frons, mesonotum and scutellum brownish pollinose; mesonotum gray-dusted laterally; face, clypeus, cheeks, occiput, pleura and abdomen dusted with gray; face, cheeks and pleura more silvery pruinose; legs brownish black, weakly gray-dusted; wings and squamae faintly brown-grayish, hyaline; halteres yellowish; all bristles and setae black.

Head: Frons broader than long, nearly flat, its lateral sides converging ventrad; frontalia with a pair of strong, proclinate interfrontal bristles almost at level of anterior ocellus and midway between anterior ocellus and fronto-orbitals, and with a few setae at its anterior margin; ocellar triangle large; ocelli minute and widely spaced; preocellars strong, lateroclinate and located at middle of line between anterior and posterior ocelli; postocellars minute; one to three setulae at middle part of

1) Scientific Survey of the Tokara Islands, Report No. 17.

2) Contributions from the Entomological Laboratory, Saikyo University, Kyoto, No. 25.

triangle; parafrontals with three pairs of strong lateroclinate fronto-orbitals between which there are three pairs of setulae; inner and outer verticals strong. Face in profile convex, upper part between antennae swollen, bare. Antennae blackish brown; third segment longer than broad, round at tip, with microscopic pile; arista slightly longer than antennae, swollen at basal one-fourth, pubescent. Cheeks with three genal bristles in an oblique line from vibrissal angle to middle of lower eye margin; the anterior genal bristle grown down- and in-wards, the other two up-curved and with two setulae below and between bristles. Proboscis large, with pale brown fleshy labellae; palpi dark brown, with a seta at tip.

Thorax: Mesonotum with 1+3 pairs of dorsocentrals, one pair of humeral, one pair of posterior notopleural, one pair of presutural, one pair of supra-alars; post-alars two, outer one strong but inner minute; three to six setulae before the line between anterior dorsocentral and presutural, and a few setulae on humeri. Scutellum with four marginal scutellars, the basal pair directed backward and the apical pair strongly upward. Mesopleura and sternopleura each with one strong bristle, the former with two relative long setae above bristle along caudal margin and one in middle of ventral margin, and with a few scattered setulae, the latter with one fine seta.

Wing: Length about 2 mm; costa ending at end of M_{1+2}, but broken once before the end point of R_1, length of section 2, 3 and 4 of costa about 8.7 : 1 : 1.5; r-m slightly before middle of cell $1M_2$.

Leg: Anterior femora with dorso- and ventroposterior rows of about 4 (3–4) long curved bristles, other hairs on legs moderate; apical tarsal segments strongly flattened.

Abdomen: Abdomen with rows of strong setae. Seventh tergite of female strongly excised in middle, its sides with five pairs of setae; eighth tergite with a pair of long dorsal bristles reaching apex of lamellae; dorsal lamellae of ovipositor (Fig. 1) bifurcate, black, dusted with light gray, with apical dorsal and preapical lateral spines black, long and flattened, and with three spine-like dorsal setae; lobes of eighth sternite each bearing five black stout spines. Male genitalia (Fig. 2) with the ventral processes of ninth tergite somewhat constricted at base, then gradually expanded in an ovoid apical lobe, outer apical margin with slender hairs and inner surface covered with strong setae; anterodorsal margin of process near base with a long finger-like lobe with fine hairs on dorsal side.

Holotype: male; Nakanoshima Is., Tokara Islands, Ryukyu; June 10, 1953; S. UÉNO leg. *Allotopotype*: female. *Paratopotypes*: 7 males, 8 females, same date as holotype. *Type-specimens*: dry, deposited in the Entomological Laboratory, Saikyo University.

The present new species is very closely allied to *N. peculiaris* MALLOCH from the Marquesas Islands and *N. zimmermani* WIRTH from Rapa Island, their chaetotaxies

are almost identical but may be distinguished by the male and female genitaliae as follows:

Nocticanace pacificus sp. nov.

Fig. 1. female genitalia, lateral view. Fig. 2. male genitalia, lateral view.

	peculiaris	*zimmermani*	*pacificus*
Male, ventral processes of ninth tergite	ventromesal apex blunty rounded	apex sharply pointed	apical lobe oval, anterodorsal lobe finger-like
Female, dorsal lamellae	slender, preapical seta on dorsal side	stout, preapical seta on dorsal side	moderately stout, preapical seta on laterodorsal side
eighth sternite	6 spines	4 spines	5 spines

MARINE INSECTS OF THE TOKARA ISLANDS

IV. BITING MIDGES (DIPTERA, HELEIDAE)[1)2)]

ETSUKO KŌMYŌ

Entomological Laboratory, Saikyo University

With one Text-figure

The present paper deals with the biting midges collected by Mr. S. MIYAMOTO and Mr. S. UÉNO at the Tokara Islands, Ryukyu. These midges are identified as follows:

1. *Culicoides arakawae* (ARAKAWA)
2. *Culicoides maculatus* (SHIRAKI)
3. *Culicoides amamiensis* (TOKUNAGA)

These species are all new records for these islands.

I wish to express my deepest thanks to Prof. Dr. Masaaki TOKUNAGA, the Chief of our Entomological Laboratory, for his kind direction on this work, and to Messrs. S. MIYAMOTO and S. UÉNO for their kindness in collecting these biting midges.

1. *Culicoides arakawae* (ARAKAWA)

This midge is very widely distributed in Japan and Formosa. Dr. T. SHIRAKI (1931) reported the female from Formosa as *C. sugimotonis*. Dr. S. MATSUMURA (1915 and 1932) also reported from Shikoku as *Ceratopogon arakawae* and Dr. M. TOKUNAGA (1937) described it in detail.

Specimens:— Two females; Takarajima; May 30, 1953.

2. *Culicoides maculatus* (SHIRAKI)

This midge has been recorded by Dr. T. SHIRAKI (1913) only from Formosa as *Ceratopogon maculatus*, by Dr. J. J. KIEFFER (1916) as *Culicoides tainana* and by Dr. M. TOKUNAGA (1937) as *C. maculatus*.

Specimen:— One female; Nakanoshima, June 4, 1953.

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1) Scientific Survey of the Tokara Islands, Report No. 18.

2) Contributions from the Entomological Laboratory, Saikyo University, Kyoto, No. 27.

3. *Culicoides amamiensis* TOKUNAGA

This species has been reported in detail by Dr. M. TOKUNAGA (1937) from Amami-Oshima. Here I intend to complete his description with my observation.

Culicoides amamiensis TOKUNAGA.
Fig. 1. Dorsal thoracic pattern.

In dry state, thorax (Fig. 1) pruinose, slightly dark brown, provided with yellow setae and yellowish or pale brown pattern. Scutum with a pair of small pale brown spots on humeral pits, a pair of pale brown stripes on lateral parts, a large yellowish brown pattern on median part, a large slightly greyish or pale brown pattern including three small brown spots on caudal part. Scutellum grey, paler on median part. Halteres white. Abdomen pale brown or yellow. Spermathecae two, almost spherical, unequal.

Specimen:— One female; Nakanoshima; June 4, 1953.

LITERATURE

TOKUNAGA, M. 1937. Sand flies (Ceratopogonidae, Diptera). Tenthredo/Acta Ent., 1 (3): 286–289, 290–295 and 325–327.

———— 1940. Biting midges from Japan and neighbouring countries, including Micronesian Islands, Manchuria, North China and Mongolia. Tenthredo/Acta Ent., 3 (2): 145.

MARINE INSECTS OF THE TOKARA ISLANDS

V. THREE NEW SPECIES OF THE GENUS *LAIUS* GUÉRIN FROM KYUSHU AND THE TOKARA ISLANDS, WITH NOTES ON A SPECIES FROM MARIANNA[1)]

TAKEHIKO NAKANE

Biological Laboratory, Saikyo University

With Plate XXV and 3 Text-figures

Laius miyamotoi n. sp.

(Pl. XXV, Figs. 1, 4-left; Text-fig. 1)

♀. Black, with rather faint bluish tinges upon elytra; antennae black, with 2nd joint reddish brown and often 1st and 3rd also more or less partly reddish; labrum and mouth organs more or less reddish, with apex of mandibles and palpi blackish; trochanters and apex of coxae also somewhat reddish; abdomen brownish with a large blackish patch on both sides of each sternite; lateral protrusible vesicles and membranous part behind procoxae reddish yellow. Body surface densely covered with rather short, suberect brownish hairs throughout.

Body oblong, rather depressed above. Head and prothorax opaque above, very thickly, strongly and rugosely punctured, the former flattened in the anterior half and gently convex behind, bearing a small fovea in the middle between the eyes and longitudinally rugose behind it. Mandibles strongly arcuate externally and sharply bifid at the apex. Labrum shining, transverse, truncate in front and rounded at the sides, finely and sparsely punctured. Clypeus short and very transverse, somewhat membranous anteriorly. Eyes oval in outline, far apart, rather small but prominent. Antennae rather robust, 1st joint long, curved and markedly widened to the apex, 2nd very short, 3rd oblong, moderately thickened, a little longer than a half of 1st, 4th to 10th short and rather stout, scarcely as long as broad, 11th ovate and obtusely acuminate terminally. Prothorax broader than the head with eyes, transverse, subcordate, widest behind the rounded front angles, sides feebly rounded and gently converging to the broadly rounded hind angles, front and basal margins very slightly arcuate or subtruncate, the latter narrowly bordered and the sides finely margined. Scutellum transverse, trapezoidal and narrowed towards the obtusely rounded hind

1) Scientific Survey of the Tokara Islands, Report No. 19.

angles, surface finely and closely punctured, the punctures distinct but less deeply set than in the pronotum. Elytra broader than the thorax at the base, slightly broadened posteriorly, a little shining, microscopically alutaceous, and minutely, shallowly and closely punctured. Head beneath transversely rugose and roughly punctured, with a deep fovea on each side. Pro- and mesopleura finely but distinctly punctured, metapleura more finely so. Metasternum minutely and not so closely punctured. Abdomen weakly chitinized for the large part, minutely and moderately closely punctured. Legs of moderate size, finely punctured and pubescent.

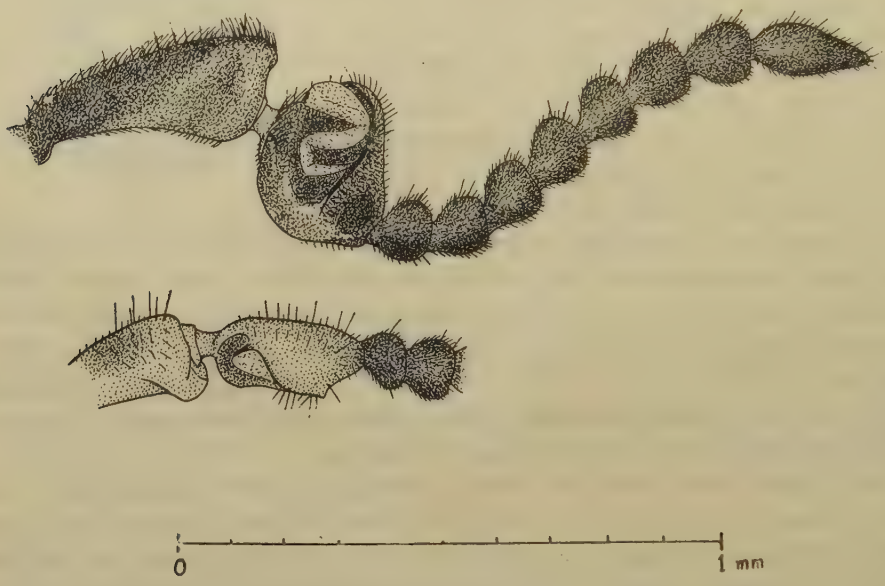


Fig. 1. *Laius miyamotoi* NAKANE n. sp. ♂ Antenna (right).
Above—dorsal view. Below—inner lateral view of proximal part.

♂. Antennae: 1st joint reddish brown, with the basal half and the inner margin blackish, curved and widened to the apex as in the female, 3rd very broadly dilated, nearly as broad as it is long, ear-shaped, above broadly and deeply hollowed in the middle and with an ovate fovea before the apex, the distal margin of the median excavation sharply raised and the inner margin bearing a flexible elongate capsular appendage which arises from a fine but sharp process. Fore femora obliquely grooved before the apex beneath; fore tibiae markedly swollen near the base and narrowed thence to the tip, beneath obliquely grooved near the base and densely clothed with fulvous hairs apically.

Body length: 4–5 mm.

Types: 3♂ 6♀ (holo-, allo- and paratypes) Takarajima, Tokara Is., 26. V. 1953, T. NAKANE leg.; 1♀ (paratype) ditto, 31. V. 1953, T. NAKANE leg.; 5♂ (paratypes)

Nakanoshima, Tokara Is., 5. VI. 1953, T. TOKIOKA leg.; 1 ♂ (paratype) ditto, 4. VI. 1953, S. UÉNO leg. (in coll. NAKANE, WITTMER, Osaka City Mus. Nat. Hist., Ent. Lab., Kyushu Univ., Zool. Sect., Nat. Sci. Mus., Tokyo and Seto Mar. Biol. Lab.).

Found on the coral reef at or below high water mark.

According to the literature the present new species is assumably closely allied to *L. flavicornis* FABRICIUS from Java, but the 1st antennal joint is lacking a dentiform tuft at the apex, the structure of the 3rd joint in the male is somewhat different, the 4th to 10th joints are shorter and scarcely as long as broad, and the male protibiae are lacking the oblong testaceous callosity at the base.

Laius asahinai n. sp.

(Pl. XXV, Figs. 2, 3 and 4–right; Text-fig. 2)

Very closely related to the preceding species, but differs from the latter in the following characteristics:

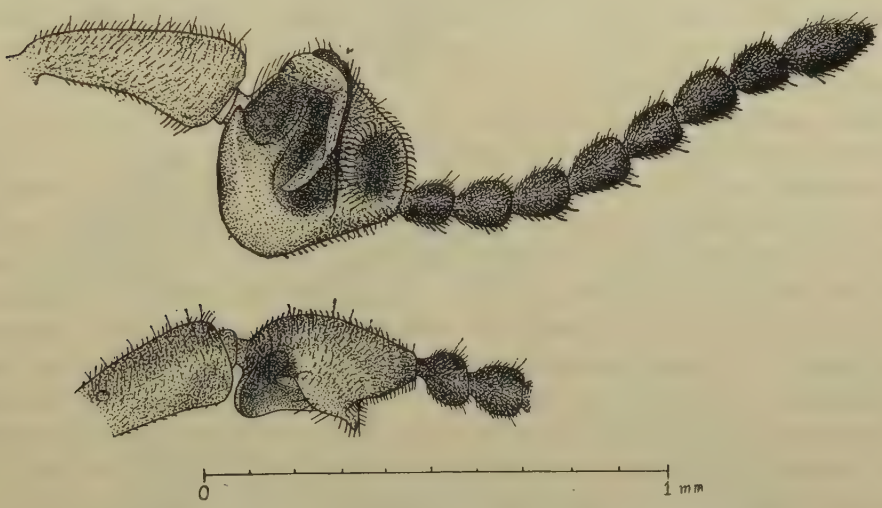


Fig. 2. *Laius asahinai* NAKANE n. sp. ♂ Antennae (right).
Above—dorsal view. Below—inner lateral view of proximal part.

1. elytra more clearly tinged with metallic blue,

2. in the male three basal joints and antennae entirely testaceous or reddish yellow, 3rd more extraordinarily expanded with the distal margin of the median excavation very highly raised, and 4th to 10th antennal joints a little longer than broad.

3. male genitalia narrower and the apex of penis acuminate, not broadly truncate.

Body length: 4.5–5 mm.

Types: 1♂ 3♀ (holo-, allo- and paratypes) Sata, Ohsumi, Kyushu, 29. V. 1952, T. NAKANE leg.; 2♂ 4♀ (paratypes) ditto, Prof. T. ESAKI leg.; 1♂ 1♀ (paratypes) ditto, Dr. S. ASAHINA leg. (in coll. NAKANE, ASAHINA, WITTMER and Ent. Lab., Kyushu Univ.)

Found on the rocks along the shore.

The examples from the Pacific coast of Honshu are somewhat different from the type-specimens of *L. asahinai* in having less coarsely punctate pronotum, but they are all females and I could not determine the relationship between two strains.

Laius takaraensis n. sp.

(Pl. XXV, Fig. 5; Text-fig. 3)

♀. Black, with bluish tinges above, shining; antennae reddish testaceous, with apical 5 joints blackish and the antecedent two more or less brownish; mandibles (apex excepted), tibiae (often infuscate in hinder legs), clypeus and labrum in front testaceous; elytra with a wide reddish yellow fascia just before the middle which widens out both at the suture and on the lateral margin; abdomen dusky reddish with a large blackish patch on both sides of each sternite. Body surface rather sparsely clothed with fulvous hairs.

Head moderately densely punctured, frons depressed, in the middle with a fine longitudinal fold which is somewhat widened and abbreviated in front. Eyes oval and prominent laterally. Antennae: 1st joint long, outcurved and markedly thickened to the apex, 2nd extremely short, 3rd shorter than 1st but nearly as broad as the latter before the apex, 4th to 10th short, 11th longer than the preceding and obtusely acuminate at the tip. Pronotum transverse, broader than the head, sides subparallel in the anterior half, then sinuately and strongly convergent to the base posteriorly, base slightly but broadly emarginate; surface rather densely punctured at the sides, and rugosely so before the hind angles, more or less sparsely and finely punctured in the middle, with a shallow transverse furrow behind the front margin and a rather broad transverse impression before the base, which is often divided into two by a fine longitudinal carina in the middle and separated from the basal margin by a transverse carina between them. Scutellum transverse, trapezoidal, narrowed to the subtruncate apex, sparsely and finely punctured. Elytra oval in outline, moderately convex, widened posteriorly and together rounded apically, not closely punctured, the punctures being less impressed near the apex. Body beneath: thoracic pleura thickly and somewhat rugosely punctured, metasternum minutely and not so closely punctured. Legs normal.

♂. Antennae: 1st joint long, widened to the apex, with a dentiform tuft above the apex, 3rd extremely large and broad, obliquely transverse, above shallowly concave, with the inner margin strongly and abruptly raised and broadly bulged in distal

half and bearing a long slender appendage just before and parallel with the basal edge of the elevation. Tibiae, trochanters, apex of coxae, fore femora, apical portion of middle femora testaceous, fore tibiae slender and simple.

Body length: 3–3.5 mm.

Types: 1♂ (holotype) Takarajima, Tokara Is., 1. VI. 1953, S. UÉNO leg.; 1 (allotype) ditto, 1. VI. 1953, Y. H. KÔNO leg.; 1♀ (paratype) ditto, 30. V. 1953, S. MIYAMOTO leg. (in coll. NAKANE and Osaka City Mus. Nat. Hist.)

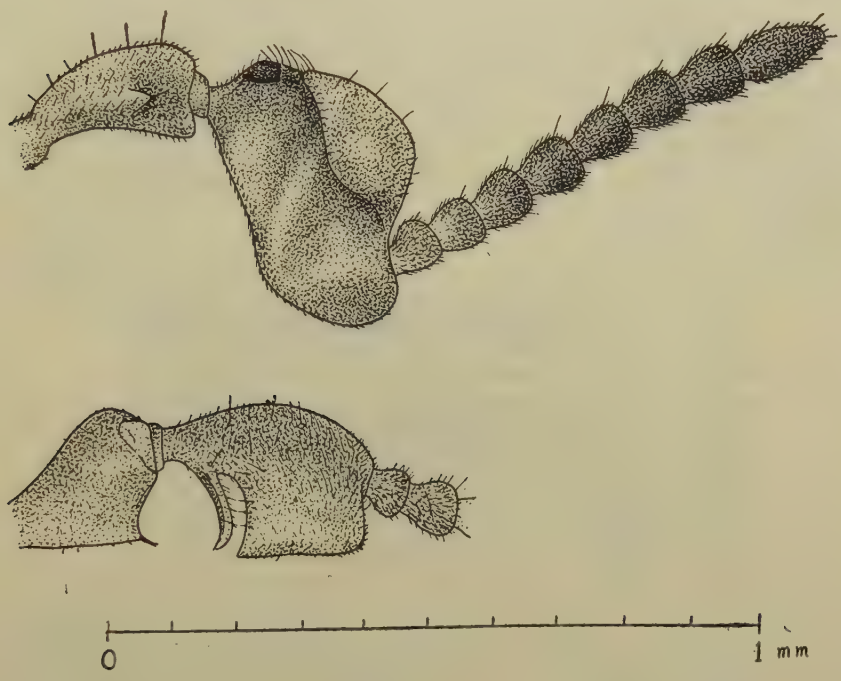


Fig. 3. *Laius takaraensis* NAKANE n. sp. ♂ Antenna (right).
Above—dorsal view. Below—inner lateral view of proximal part.

This species is a close ally to *L. niponicus* LEWIS from Japan, and may be distinguishable from the latter in having distinct bluish tinges on the body above, a dentiform tuft above the apex of 1st antennal joint and differently-shaped 2nd joint in the male.

Found on the sand-beach.

Note: LEWIS mentioned in his description of *L. niponicus* that the body is black, or with a bluish tint, but a small series of examples before me are all lacking metallic blue tinges above.

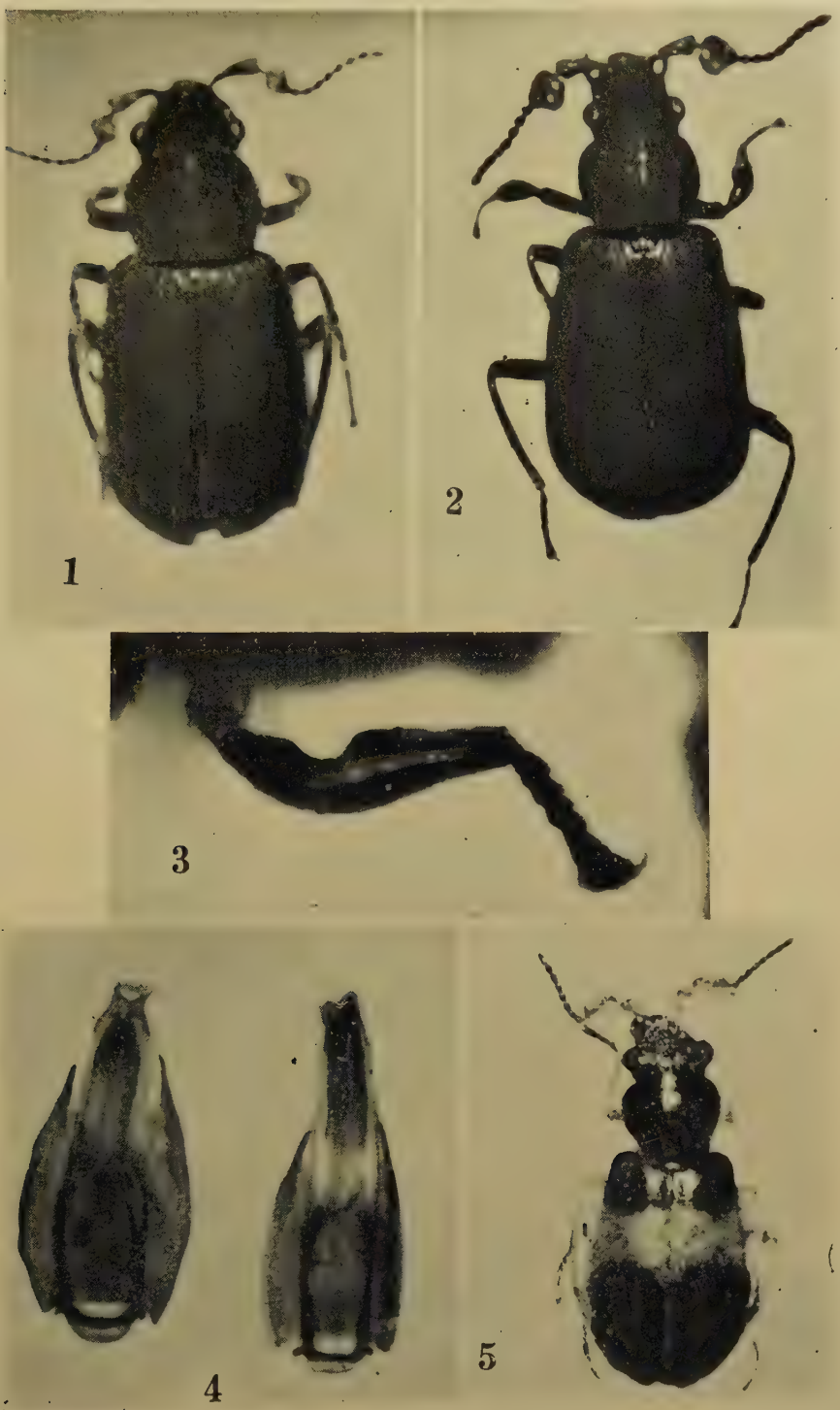
On *Rotamalachius esakii* KÔNO from Rota Island

In 1937 Dr. H. KÔNO described an interesting halophilous Malachiid from Rota Is., collected by Prof. T. ESAKI, and he named it *Rotamalachius esakii* (n. g. & n. sp.). In the course of my study, however, I found that this species belongs to the genus *Laius* and assumed that it would be nearly allied to *L. cyaneus* GUÉRIN from New Guinea, the type of the genus. Responding to my inquiry Dr. Walter WITTMER in Buenos Aires, one of the authorities of Malacoderm Coleoptera of the world, kindly informed me that he confirmed already the synonymy of *Rotamalachius esakii* with *Laius marchei* PIC from Marianna, of which he examined the type in the Paris Museum.

In conclusion, I wish to express my sincere thanks to Prof. Dr. T. ESAKI and Dr. S. ASAHINA for their kind help for my study, and also to Dr. W. WITTMER for his kind suggestion. Further I am much indebted to Mr. Y. TSUTSUI, director of the Osaka Municipal Museum of Natural History, and other members of the scientific expedition to the Tokara Islands for their agreeable assistance rendered me during the survey.

EXPLANATION OF PLATE XXV

Fig. 1. *Laius miyamotoi* NAKANE n. sp. ♂
Fig. 2. *Laius asahinai* NAKANE n. sp. ♂
Fig. 3. *Laius asahinai* NAKANE n. sp. ♂ protibia (right)
Fig. 4. Male genitalia of *Laius*: left—*L. miyamotoi*;
right—*L. asahinai*.
Fig. 5. *Laius takaraensis* NAKANE n. sp. ♂



T. NAKANE: MARINE INSECTS OF THE TOKARA ISLANDS, V.

MEERESINSEKTEN DER TOKARA INSELN[1]

VI. COLLEMBOLEN NEBST BESCHREIBUNGEN TERRESTRISCHER FORMEN[2]

Ryozo YOSII

Biologisches Institut der Yoshida-College, Kyoto Universität

Mit 10 Abbildungen

Eine Anzahl von Collembolen, die von S. Uéno auf seiner Forschungsreise nach der genannten Inseln eingesammelt und mir zur Untersuchungen geliefert wurde, enthält einige ganz interessante Formen von vornehmlich südlicher, tropischer Elemente. Besucht wurde von ihm dabei zwei Inseln: Takara-zima (Tresorinsel) und Nakanosima (Mittelinsel), wo die Materialien aus drei folgenden Biotopen erbeutet sind.

(1) Korallenriffe und Brandungsufer:
Pseudanurida billitonensis Schött*
Yuukianura halophila g. n., sp. n.
Axelsonia littoralis (Moniez)*

(2) "Asibikigô-no-Iwaya" Höhle von Takarazima:
Xenylla sp.
Folsomia fimetaria L.
Pseudosinella duodecimocellata E. Handschin
Lepidocyrtinus taeniatoides sp. n.
Sinella arcuata sp. n.
Monodontocerus modificatus g. n., sp. n.
Arrhopalites binoculatus Börner

(3) Auf der Erde, zwischen befallenem Laub:
Paranura s-uénoi sp. n.
Folsomia octoculata E. Handschin
Isotoma trispinata MacGillivray
Isotomurus palustris (Müller), f. *fucicola* (Reuter)*
Homidia sauteri Börner

1) Kleine Inselgruppe nördlich von Okinawa.

2) Ergebnisse der wissenschaftlichen Expedition zur Tokara Inseln, Nr. 20.

Publ. Seto Mar. Biol. Lab., IV (2-3), 1955. (Article 34)

Homidia socia Denis
Homidia nigrocephala H. Uchida*, f. *obscura* f. n.
Entomobrya tokunagai Yosii
Sinella umesaoi Yosii
Willowsia bimaculata (Börner)
Willowsia japonica (Folsom)
Lepidosira nilghiri (Denis)*
Corynothryx sinensis (Denis)
Akaboshia matsudoensis Kinoshita
Tomocerus kawamurai Yosii, f. *depicta* f. n.
Cyphoderus sp.
Ptenothryx tsutsuii sp. n.
Ptenothryx corynephora Börner, f. *shibanaii* f. n.

(Die hiermit neulich aus dem japanischen Faunengebit gemeldeten Formen sind mit Sternzeichen begleitet.)

1. *Xenylla* sp.

1 Expl. Höhle in Takara-zima (26. V 1953).

Die Form hat nur 4+4 Augen und fällt somit in einer wenig bekannten Gruppe der X. octoculata-similata-yucatana Serien. Da das Exemplar keinen IZ und KH hat, scheint er keiner bisher bekannten Species angehören.

2. *Pseudanuria billitonensis* Schött

(Abb. 1)

1901. Schött, Termesz. Füz. **24**: 371.

25 Expl. aus Takara-zima (1. VI 1953).

Körperlänge bis 3.0 mm. Farbe intensiv blauschwarz. Nur die Segmentgrenze des Rumpfes und einige kleine Punkte an beider Seite des Segmentes sind weisslich. Alle Extremitäten sind gleich gefärbt. Eine Ausnahme bildet die Furka und ihr Insetionsstelle die violett sind. Antennen so lang wie Kopfdiag. Ant. III und IV getrennt. Ant. III-organ besteht aus einem paarigen schlanken Sinnesstiftchen in einer leichten Grube. Die Spitze des Ant. IV trägt dorsal 3 merkwürdigerweise granulierten Tuberkeln und 3 mit Sockel versehenen Spitzborsten. Pa. O. fehlt. Ommen 8+8, auf schwarzem Feld. Mundkegel ist stark entwickelt. Mandibel ist dreieckig verbreitert und an der Innenlade mit einer Reihe von 25-30 fast gleichgrossen Zähnchen versehen. Maxillen stylettförmig. Die alle gleich geformte Klaue ist dorsal gekielt und mit einem grossen IZ. Das Empodium ist gut entwickelt aber ohne EA. Innenseite der Klaue ist basal stark granuliert und

in violetter Farbe. KH fehlend. Furka ist, wie von dem Habitusbild ersichtlich, ausserordentlich verlängert. Sie besteht aber nur aus dem Dens und Manubrium, da das Mucroteil mit Dens beinahe verwachsen ist. Das in seiner ganzen Länge fast

Abb. 1. *Pseudanurida billitonensis* SCHÖTT.

A: Habitus, B: Antennenspitze, C: Ant. III-organ, D: Ommen, E: Mandibel, F: Maxille, G: Vorderklaue, H: Tenuculum, I: Dorsale und ventrale Seite des Abdomenende, J, K: Dorsale und ventrale Seite des Mucrones, L, M: Ditto von einem jungen Exemplar.

gleichbreite und schön granulierte Dens trägt eine reihe von 5 glatten Borsten. Mucro, das nur bei Jugendform von dem Dens zu unterscheiden ist, ist ein vierkantiger Schaft. Im jugendlichen Stadium sind die dorsale und die ventrale Kante

unscheinlich und die beiden Seitenkanten breit, ganzrändig und schön geflügelt. In dem erwachsenen Zustand verlängert sich die Mucroschaft, sammt mit seiner Seitenflügel derweise, dass die ventrale Seite viel länger sind als die dorsale. Die laterale, geflügelte Lammelle ist inzwischen verschmälert und das Gelenk zum Dens aufgelöst bis man es nur durch relativ grosser Hauttuberkel nahe an der Basis der ventralen Kante zu bemerken hat. Tenaculum ist mit dreizähnigen Rami und einer vorderen und hinteren Wölbung, die stark granuliert sind. Auf dem Abd. VI ist die Oberlappe des Anus sehr gut entwickelt und nach hinten vorgezogen, die beiden rundlichen Laterallappen unter sich deckend. Das direkt vor dieser Laterallappen sich befindliches Genitalfeld ist rundlich, granuliert und mit ca. 30+30 kleinen Bosten versehen. Die ganze Körperoberfläche ist überall gleichmässig granuliert. Das Haarkleid ist mässig lang und glatt. Es wird nur leicht länger am Abd. VI, wo einige Haare in abgesetzter Spitze endigen.

Diese aus dem Südseeinsel Billiton bei Malaya beschriebene und seither nicht gemeldete Form ist überraschenderweise aus unserem Reichsgebiet gefunden. Es muss eine echt tropische Strandfauna darstellen. Da die Gattung *Pseudachorutides* aus dem Nahen Osten eine ganz andere Mundapparate bei sich trägt, ist *Pseudanurida* vorläufig eine monotypische. Interessanterweise hat aus Annam bekannte *Ceratrimeria caudata* Denis etwas ähnlich gebaute Mandibeln, Klaue und Abdomenende.

3. *Paranura s-uénoi* sp. n.

(Abb. 2)

3 Expl. aus Nakanosima (12. VII 1953).

Körperlänge bis 3.0 mm. Farbe dorsal blaugrau und ventral farblos. Von der Antenne bis Abd. VI sind die Pigmente gleichmässig zerstreut. Die einzelne Hautgranula färbt sich isoliert wie bei *Odonthella*. Ant./Kopf wie 4:5 Ant. III und IV vollkommen verwachsen zu einem Endglied. Ant. IV apikal mit 3 rundlich glatten Endkolben und 5–7 gerundeten Riechhaaren, die besonders an der Aussenseite liegen. Ant. III–org. besteht aus einem paarigen, stark an einer Seite geneigten Sinnenstiftchen, die in einer tief begrenzten Grube sich befinden. Ihre Schutzborsten scheinen nicht differenziert zu sein. Auf dem Kopf sind 3+3 einzeln schwarz pigmentierte Ommen, von denen die vordere zwei nebeneinander und entfernt von der hinteren liegen. Pa. O. fehlend. Mundkegel ist schwach entwickelt und spitz endigend. Mandibel ist apikal dreizähnig wie bei *Paranura coeca* Folsom. Maxille ist stylettförmig. Die alle gleich gebaute Klaue sind dorsal stark gekielt und innen stark granuliert bis an das Ende. IZ, EA, und KH fehlend. Von der Furka ist überhaupt nichts zu bemerken. Analplatten sind länglich und an der Mitte tief eingespalten, die beiden Teilen, jedoch, nicht vollkommen halbierend. Das ganze Abd. VI und die laterale Seite des Abd. V sind schmal mit gefeldertem Hautbezirk gefranst, wo, im Gegensatz zu der anderen Teile des Tergits, ausser der Granulier-

ung auch noch die Felderung mit deutlicher Furche vor sich geht, welche an der Insertionsstelle der Körperborsten rosettenartige Anordnung aufnimmt. Das Integument ist überall grob granuliert. Hier und da, dorsal wie ventral, gibt es einige Stelle, wo die Granulierung gefehlt und die Hautpigmente nicht vorhanden sind. Es erscheint als ob hier Pseudocellen geben, was aber nicht der Fall ist. Körperhaarkleid einfach und mässig lang.

Von der drei bis jetzt bekannten *Paranura*-Arten, unterscheidet die Form durch das Retikulum des Abdomenende. In der Augenverteilung und Körperfarbe ähnelt

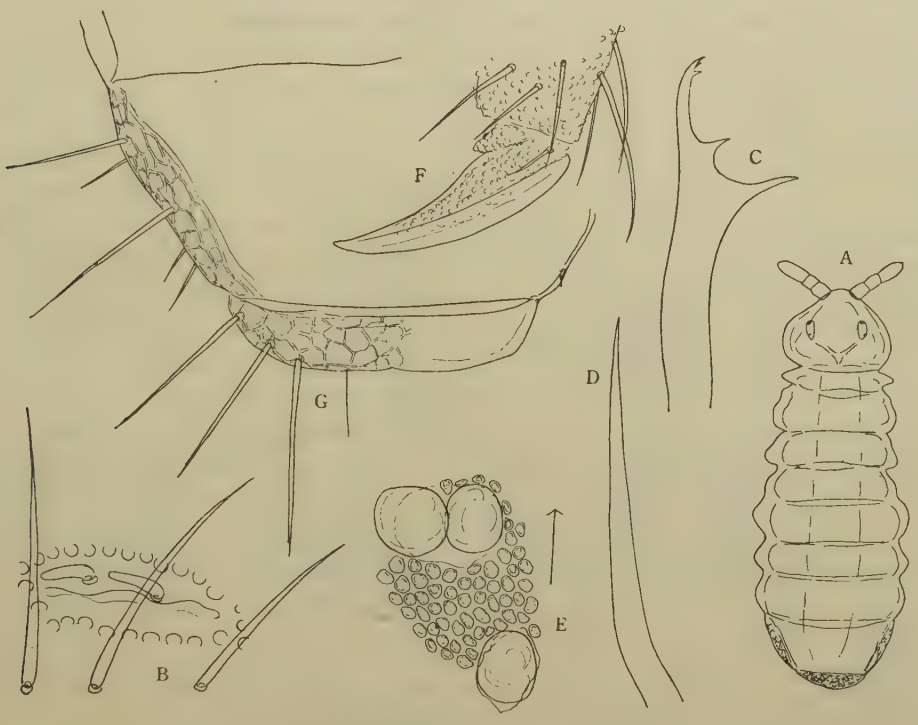


Abb. 2. *Paranura s-uénoi* sp. n.

A: Habitus, B: Ant. III-organ, C: Mandibel, D: Maxille, E: Ommen, F: Mittelklaue, G: Abdomenende.

die Art zu *P. sexpunctata* Axels und besonders zu seiner Varietät: f. *colorata* Mills. In der Ant. III-org. und Mandibel ist sie, dagegen, der Nordamerikanischen *P. coeca* Folsom näher gestellt.

Yuukianura g. n.

Körpergestalt sehr schlank. Dorsale Reihe der Körpertuberkeln ist nur mit Borsten angedeutet. Andere Tuberkeln sind auch sehr schwach entwickelt. Mandi-

beln mit 6 Zähne. Maxillen mit dreizähniger Gelea und fadenförmig verlängerter Lacinia und Palpis. Sonst wie *Protanura*. Der Name ist zu Ehren des Herrn Jitsusei Yuuki der Katata-Volksschule genannt.

Genotypus: *Yuukianura aphoruroides* (Yosii).

Syn. *Protanura aphor.* Yosii 1952 Annot. Zool. Jap. **26**: 69.

4. *Yuukianura halophila* sp. n.

(Abb. 3)

8 Expl. aus der littoralen Korallenriffe von Nakanosima (8–9. VI 1953).

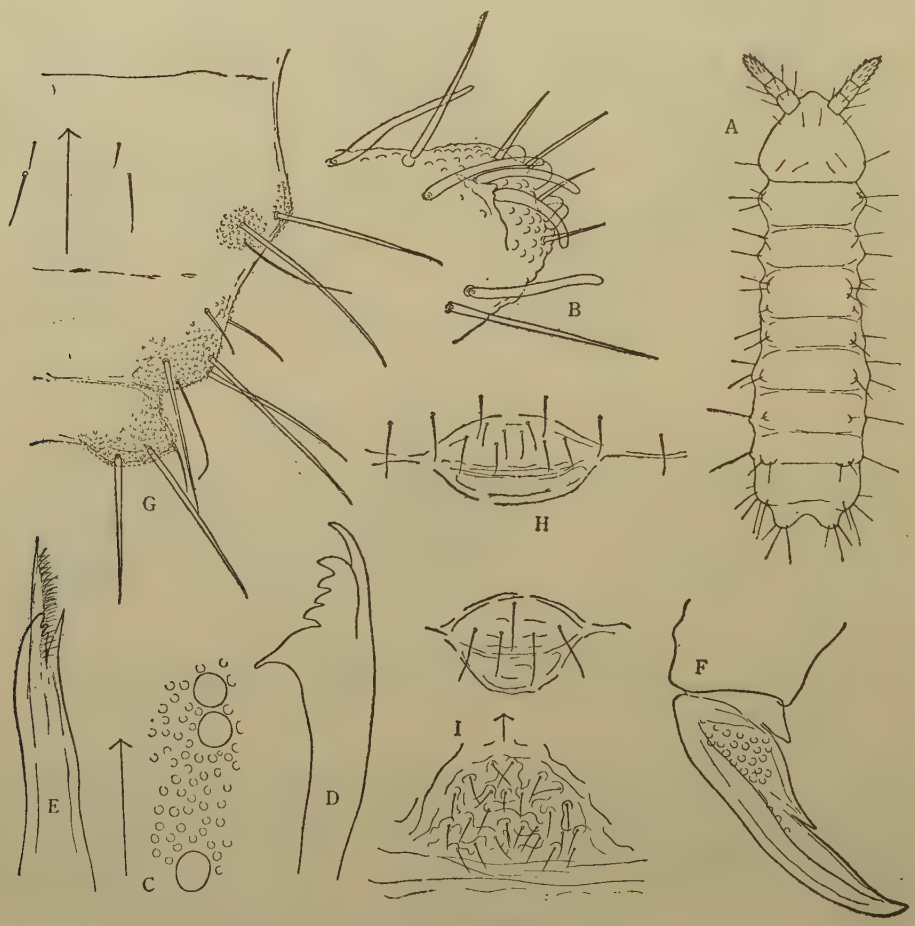


Abb. 3. *Yuukianura halophila* g. n., sp. n.

A: Habitus, B: Antennenende, C: Ommen, D: Mandibel, E: Maxille, F: Hinterklaue, G: Abdomenende, H: Furkarest, I: Genitalfeld.

Körperlänge bis 3.0 mm. Gestalt schlank wie bei *Y. aphoruroides* (Yosii) oder noch mehr. Farbe reingelb im Leben und vollkommen weiss im Alkohol. Antennen so lang wie Kopf. Ant. III und IV dorsal verwachsen. Ant. IV mit 3 Endkolben, 4 aufrechtstehenden Borsten und 6 geneigten Sinneshaaren, zwei davon in dem kurz vor der Spitze liegenden, leichten Grubchen sich befinden. Ant. III-org. sind zwei stark an der Seite geknickten Sinnesstäbchen in einer Grube. Mundkegel ist normal entwickelt. Der Mandibel ist mit 6 Zähnen, von denen der proximale der grösste und die distale sehr lang vorgezogen. Maxillenkopf ist kompliziert gebaut. Die dreizähnige Galea ist gut chitinisiert. Die Lacinia ist zurückgebildet zu einem stümmelförmigen Fortsatz an der Galea und Palpis ist weit von der Galea ausgezogener, schmal lamellierter und mit mehrerer Kammzähnen gefranster Bart. Augen 3+3, in normaler Anordnung und pigmentfrei. Pa. O. fehlend. Die in allen Beinen gleich gebaute Klaue ist mit einem deutlichen IZ, dorsal gekielt und nur an der Basis deutlich granuliert. Obgleich die Furca nicht ausgebildet ist, findet man an ihrer Stelle den bosonderen Hautbezirk, wo 5–7 kleine Borstchen sich ansammeln. Anallappen normal. Genitalfeld halbkreisförmig, unregelmässig krenuliert und mit mehreren Borsten beschmückt. Körpergestalt sehr lang. Haut wenig tuberkuliert. Segmenthöcker sind sehr schwach entwickelt. Auf dem Kopf ist nur noch die Augentuberkel wahrnehmbar. Auf dem Rumpf sind alle dorsale und mediale Höckerreihen nur noch durch die längere Borsten angedeutet. Th. I hat 1+1 Höcker der lateralen Reihe. Th. II–Abd. IV ist mit 2+2 Höcker (dorsolaterale und laterale) versehen. Auf dem Abd. V, wo bei *Y. aphoruroides* 2+2 Höcker nebeneinander stehen, sind sie zu einer Masse vereinigt auf welcher 3 langen Borsten zusammen mit einer Seta sensualis sich befinden. Das Haarkleid normal und nach hinten länger werdend. Alle Haare sind glatt und ungefärbt.

Die Form ist von der genotypischen Art durch die Körperfarbe und die Segmenthöcker am Abd. V zu unterscheiden.

5. *Axelsonia littoralis* (Moniez)

Isotoma nitida, Folsom, 1899 Proc. Am. Acad. Art Sci. **34**: 15.

12 Expl. Nakanosima (5. VI 1953)—9 Expl. Takara-zima (26. V 1953).

Die Materialien stimmen gut überein mit der Beschreibung europäischer Forschern. Was ich hiermit hinfügen möchte, sind folgende: Die ventrale Seite des Manubriums ist mit zahlreicher Borsten wie bei *Isotoma*. Dens/Manubr. wie 2.2. Rami des Tenaculums 4-zähnig und mit 2+2 Borsten begleitet. Die Annahme Gisin's (1944 Hilfstab. holarkt. Coll. 65) dass *Ax. nitida* (F.) eine selbständige, von *Ax. littoralis* durch De./Man. zu unterscheidende Art darstelle, ist nicht berechtigt. Folsom selber hat in dem der Originalbeschreibung beigelegten Habitusbild das Verhältnis richtig gezeichnet, obgleich er es irrtümlich wie 4/16 gemessen hatte.

6. *Isotoma* (*Isotoma*) *trispinata* MacGillivray

(Abb. 4)

Is. tr. Folsom 1937, U.S. Nat. Mus. Bull. **168**: 92—H. Uchida, 1943, Bull. Tokyo Sci. Mus. 8: 12—H. Gisin, 1944, Hilfstab. hol. Coll. 61—E. Maynard, 1951, Coll. New York State 113.

2 Expl. Nakanosima (8. VI 1953).

Körperlänge ca. 1.8 mm. Dorsal graublau durch diffuse Färbung. Antennen gleich gefärbt wie der Körper. Segmentgrenze des Rumpfes heller. Unterseite des Körpers, sowie der Beine und die Furka weniger gefärbt und am Ende farblos. Ant./Kopf wie 1.5/1.0. Ant. IV mit einer undeutlichen Erhebung und winzigen Knöpfchen am

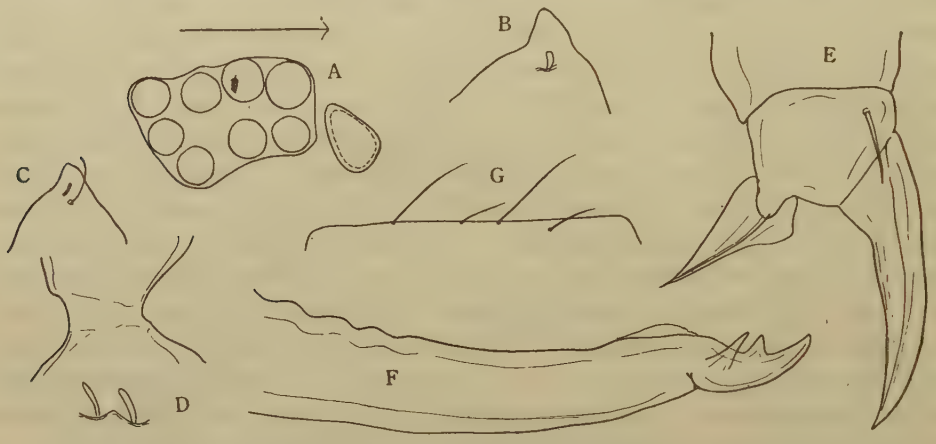


Abb. 4. *Isotoma trispinata* MacGillivray.

A: Ommen mit Pa. O., B, C: Antennenende, D: Ant. III-organ, E: Hinterklaue, F: Mucro, G: Abd. II.

Ende. Ant. III-organ normal, paarweise nebeneinanderliegend. Das direkt vor dem Ommenfeld liegende Pa. O. ist ca. 1.5-mal so gross wie Ommendurchmesser. Alle Klaue gleich gebaut. IZ. fehlend. Ein paariges DZ ist nur in günstiger Lage und zwar nur im Frontalansicht zu bemerken und im Profil überhaupt nicht sichtbar. De./Ma. wie 2.7. Man. mit vielen Ventralborsten. Mucro dreizähnig. Apikalzahn lang gestreckt. Anteapikal breiter. Basalzahn zugespitzt und an der Aussenseite angehaftet. Tenaculum mit 4-zähnigen Rami und Corpus, welches bei einem mit 6, bei anderem mit 7 kleinen Borsten versehen ist. Das Haakleid einfach. Auch die längste Borste des hinteren Teile des Abdomens ist glatt und farblos. Abd. III und IV fast gleichlang. Längste Borste/Segmentbreite am Abd. II wie 1/5.

Die vorliegende Exemplare stimmen mit der Folsom'schen Beschreibung gut überein. Ob die Art der europäischen *Isotoma maritima* Tullberg so unterscheiden lässt, wie Gisin, H. (1944 loc. cit.) citiert hat, bleibt noch im Frage.

7. *Folsomia fimetaria* L.

2 Expl. Asibikigô-Höhle, Takara-zima (26. V 1953).

8. *Folsomia octoculata* HANDSCHIN

1 Expl. Nakanosima (6. VI 1953).

9. *Isotomurus palustris* (MÜLLER), f. *fucicola* (REUTER)

1 Expl. Nakanosima, Tokara (12. VI 1953).

Die viel bestrittene Aufgabe, die *Isotomurus palustris* zu verschiedenen Arten bzw. Lokalrassen abzuspalten, gelingt mir vorläufig nicht für die japanischsn Arten. Die Versuche BÖRNERS (1906) und DENIS' (1948) die asiatischen Formen durch das Vorhandensein von einer winzigen AZ und die Furche zwischen dieser und ihm nebenstehenden IZ wie *Is. tricuspis* (BÖRNER) aufzuteilen, scheint mir noch nicht berechtigt zu sein, insofern, ich in der japanischen Exemplare von *Is. pal. prasina* (RT.) das entsprechende Bild bemerkt habe.* Andererseits habe ich die Hoffnung ob die Verteilung der die Gattung charakterisierenden gefiederten Borsten am Abdomenende nicht zu verwechseln mit Setae Sensualis—eine Unterscheidungsmerkmal darbietet. Denn ich habe bei f. *prasina* nur noch einer von solchen auf der dorsalen Lappe des Anus und nichts auf der lateralen Lappen gemerkt habe, während sie bei f. *fucicola* auch noch auf der lateralen Lappen je 2 vorhanden sind. Da ich nicht die europäischen Materialien bei mir habe, kann ich der Frage nicht tiefer eingehen. Eine Sammlung in Madrid (Casa de Campo), welche ich zuerst wie *Is. pal. principalis* verkannte, bewies sich, bei näherer Untersuchung, wie *Isotoma mauretanica* HANDSCHIN (1926), was natürlich keine Seta Sensualis noch gefiederten Borsten bei sich trägt. Interessanterweise trägt die Form auch solch ein winziger AZ und eingebuchtete Furche an der Klaue bei sich. Alle japanischen Exemplaren von *Is. palustris* haben die Klaue und EA ohne IZ, wie der javanische Vertreter: *Is. tricuspis* BÖRNER.

10. *Sinella arcuata* sp. n.

(Abb. 5)

Körperlänge ca. 1.0 mm. Farbe vollkommenweiss. Allgemeine Beschaffenheit wie bei *Sinella höfti* (SCHÄFFER), aber das Haarkleid kleiner und spärlicher. Die Klaue sind verschmälert an der Stelle ca. 2/3 von der Basis und dann stark zugespitzt.

* Nach Abschluss des Manuskriptes erfuhr ich dass AZ und die Furche oft bei der europäischen Formen zu treffen sind. (GOTO, 1953 Jnl. Soc. British Entom. 4: 181)

Tibiotarsen tragen keinen glatten Borsten. Nur KH und Gegenborste am B3 sind glatt und zugespitzt.

Co-typus: 25 Expl. aus der Asibikigô-Höhle, Takara-zima (25. V 1953).

Anmerkung: Fast alle japanische Höhle beherbergen die *Sinella*-Arten, die von der kosmopolitischen *Sinella höfti* (Schäffer) durch die Beschaffenheit der Klaue sich zu unterscheiden sind. Der Fall scheint mir ungefähr so, wie bei der *Pseudosinella*-Arten der Spanischen und Südfrankreichschen Höhlen. In allen diesen Formen, habe ich bis jetzt niemals die Gattung charakterisierenden, tibiotarsalen nackten Borstenreihen aufgefunden. Die vorliegende Art ist auch nicht die Ausnahme. Da die zum Vergleich untersuchte edaphische Exemplare von *Sinella höfti*

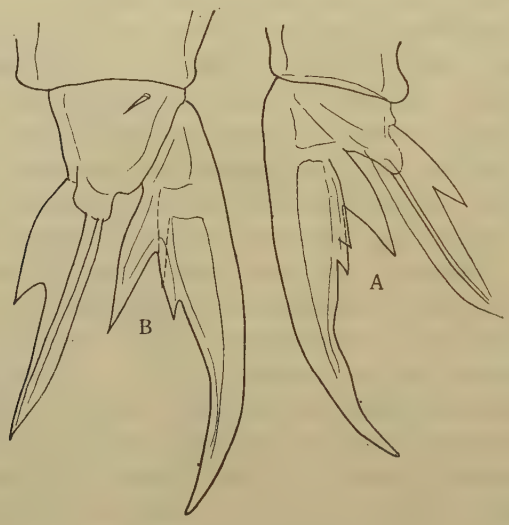


Abb. 5. *Sinella arcuata* sp. n.
A: Vorderklaue, B: Hinterklaue.

im Japan auch die sonst bei allen anderen japanischen *Sinella*-Arten wie *S. umesaoi*, *curviseta*, *straminea* etc. sehr deutlich bemerkbaren nackten Borsten nicht beweisen, nehme ich die Möglichkeit an, ob die blinde *Sinella*-Arten mit sichelförmigem Mucro überhaupt von der sonstigen Formen zu trennen sei. Die vorliegende Form ist von der sehr unzureichend beschriebenen Form *S. höfti*, *spinidentata* Yosii 1942 nur durch die Klaue zu unterscheiden.

11. *Sinella umesaoi* Yosii

2 Expl. Nakanosima (16. VI 1952).

12. *Entomobrya tokunagai* Yosii

Yosii, 1942. Arch. Natg. **10**: 480.

3 Expl. Takara-zima (26. V 1953).

13. *Homidia socia* Denis

1 Expl. Takara-zima (27. V 1953).

14. *Homidia sauteri*, f. *principalis* Börner

1 Expl. Takara-zima (26. V 1953).

15. *Homidia nigrocephala* H. Uchida, f. *obscura* f. n.

(Abb. 6, A–E)

Uchida, H. 1943. Bull. Tokyo Sci. Mus. 8: 7.

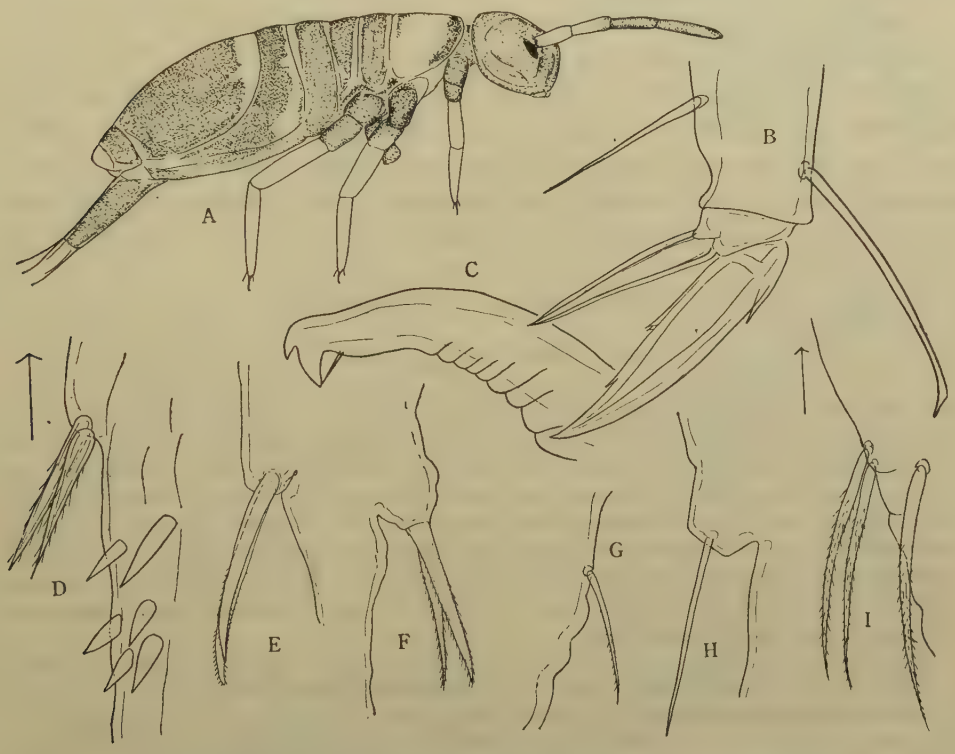


Abb. 6. *Homidia nigrocephala* H. Uchida, f. *obscura* f.n. (A–E) und die dentale Tuberkeln anderer Formen.

A: Habitus, B: Hinterklaue, C: Mucro, D, E: Dentale Tuberkel, F: Ditto von *Homidia sauteri* Börner, G: Ditto von *Sinella curviseta* (Brook), H: Ditto von *Salina celebensis* (Schäffer), I: Ditto von *Entomobrya tokunagai* Yosii.

Körperlänge 1.8 mm. Grundfarbe des Körpers weisslich auf welcher schwarzviolett bis braunviolette Zeichnungen sich befinden. Ant. I und II weiss. Ant. III intensiv und IV leicht rotviolett. Der ganze Kopf, Halsgegend und Th. III–Abd. V sind mit Ausnahme der Segmentgrenze intensiv pigmentiert. Nur Th. II und Abd. VI sind hell. Auf der Beine sind die Coxen und manchmal Trochantere, sowie Ventraltubus gefärbt. Furka am Munubrium diffus pigmentiert. Ant./K. wie 1.7. Ant. Verh. wie 1.0 : 2.3 : 1.7 : 2.9. Ant. IV ist durch Borstenanordnung andeutungsweise geringelt. Auf der Beine sind KH distal erweitert und am B3 die Gegenborste vorhanden. Die Klaue ist normal. Paarige AZ nahe an der Basis deutlich. Prox. IZ sehr deutlich und mit 2 distalen Zähnen begleitet. EA lanzettlich zugespitzt und ca. 3/5-mal der Klaue. Tenaculum mit 3-zähnigen Rami und einer langen, vor der Rami stehenden Borste.

Dentaldornen 9–22 in 2–3 Reihen angeordnet. Sie sind also stark variabel im Zahl. Jeder Dorn relativ schmal und schwach chitinisiert. Mucro zweizähnig mit Basaldorn. Anteapikalzahn ist grösser als Apikal. Distale glatte Partie des Dens ca 1.4-mal des Mucro.

Co-typus: 6 Expl. aus Nakanosima, Tokara (8. VI 1953).

Weitere Fundorte: Takarazima (20 Expl. 26. V 1953).

Anm.: Die Bedeutung der in der Diagnose Uchida's beschriebenen Basalstück des Dentes (stout papilla on the basal part of dens) ist unten behandelt.* Die Form weicht von der Hauptart nur durch die fast ganz gefärbten Abd. IV, welcher bei f. *principalis* nur an dem vorderen Rand breit gefärbt ist. Der stark gefärbte Kopf und Ant. III ist bei dieser Art sehr auffallend.

16. *Willowsia japonica* (Folsom)

1 Expl. Nakanosima (5. VI 1953).

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* Die Basaltuberkel des Dentes, die zuerst von H. Uchida (1943. Bull Tokyo Sci. Mus. *8*: 7) auf *H. nigrocephala* aus Formosa gefunden und wie arteigen bezeichnet wurde, ist nicht nur bei der citierten Art, sondern auch bei *H. sauteri*, (Abb. 6, F) wahrzunehmen. Scheinbar stellt sie, neben Bedornung des Dentes, eine gattungseigene Character dar. Die Zahl der auf dieser Tuberkel anzutreffenden Borsten ist von H. Uchida wie eins berichtet. Ich habe bei allen Exemplaren zwei davon zu zählen. Sie sind leicht gefiedert und nicht gleichlang (?). Die Beschaffenheit der Tuberkeln ist schon bei der Cyphoderiden (Delam.-Deboutteville, 1948 Arch. zool. exp. gen. *85*: 276) wie "Accrochage des Dentes" bezeichnet. Ich füge hierbei einige Beispiele davon:

1. *Entomobrya tokunagai* Yosii: (Abb. 6, I.)– Tuberkel nicht vorhanden. Zwei besonders lange und dicke Fiederborsten sind an der betreffenden Stelle zu sehen.
2. *Willowsia japonica* (Folsom):– Tuberkel fehlt. Eine winzige Borste ist vorhanden.
3. *Sinella curviseta* Brook: (Abb. 6, G)– Tuberkel fehlt. Eine Borste, die nur durch Benützung von Ölimmersion wie gefiedert wahrzunehmen ist, ist vorhanden.
4. *Salina celebensis* (Schäffer): (Abb. 6, H)– Ein grosser Sockel von Tuberkel, auf welchem eine scheinber glatte Borste vorhanden.
5. Bei der Tomoceriden kommt sie nur bei *Pogonognathellus flavescens* (Tullberg) zum Vorschein und zwar mit hyalinem, schuppigem Anhang.

17. *Willowsia bimaculata* (BÖRNER)

6 Expl. Takara-zima (26. VI 1953).

18. *Lepidocyrtinus taeniatoides* sp. n.

(Abb. 7, A–D)

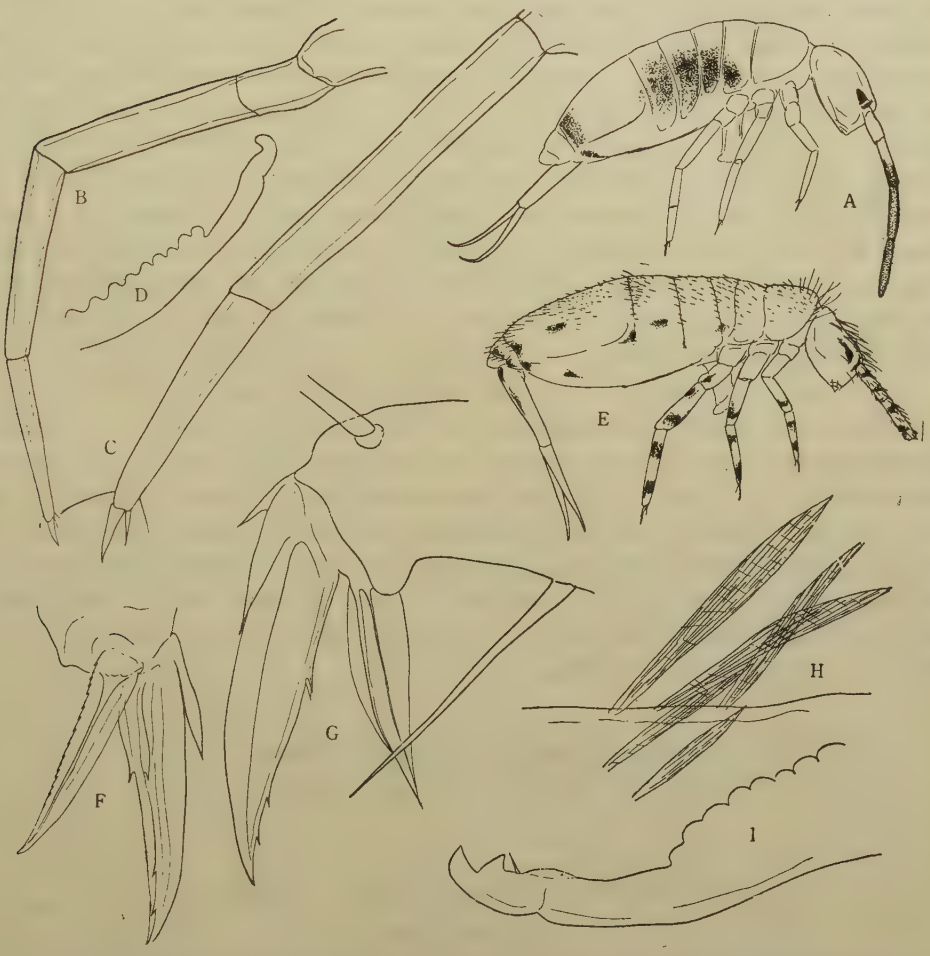

Abb. 7. *Lepidocyrtinus taeniatoides* sp. n. (A–D) und *Lepidosira nilghiri* (DENIS) (E–I)
A: Habitus, B: Hinterbein, C: Hinteres Tibiotarsus, D: Mucro, E: Habitus, F: Vorderklaue, G: Hinterklaue, H: Dentale Beschuppung, I: Mucro.

Körperlänge 1.7 mm. Grundfarbe milchig weiss. Antennen sind zu rotviolett pigmentiert. Am Ant. I und II sind die Farbe blasser, aber, mit violettem Rand. Auf dem Kopf beschränkt sich die blauviolette Zeichnung nur an der beiden Anten-

nenbasis und dazwischen liegendem Vorderrand des Kopfes. Augenfelder schwarz. Die Zeichnung des Rumpfes ist sehr blass und als ein paariger Fleck seitlich von Th. III–Abd. III. Hinterteil des Abd. IV ist ausserdem eng gefärbt. Ant./K. wie 2.0. Ant. Verh. wie 1.0 : 1.3 : 1.5 : 1.7. Ant. IV mit einem winzigen Endkolben. Ant. IV ohne Ringelung. Borstenansatz des betreffenden Segments nicht quirlartig. Augen normal. Abd. III/IV wie 1.0 : 3.2. Die Beine sind normalerweise beborstet. Die Klaue ist schlank und mit 2 IZ. Prox. Z. an der Mitte und Dist. Z. ca. 3/4 von der Basis entfernt. AZ weit nach der Spitze verschoben wie sie ca. 1/2 von der Basis entfernt. EA lanzettlich zugespitzt. K/EA am B3 wie 1.7. KH normal. KH/K am B3 wie 1.1. Gegenborste ist nur am B3 vorhanden und ihre Länge ist ca. 2/3-mal der des betr. KH. Das Tibiotarsus am B3 ist an der Mitte mit einem Gelenk versehen und somit in zwei Teilen geteilt. Furka gut entwickelt. Man./D. wie 1.0 : 1.3. Dentes deutlich geringelt und ventral beschuppt. Basaltuberkel schlecht entwickelt etwa wie bei *Entomobrya*. Mucro sichelförmig, gekrümmt und ohne Basaldorn. Distale glatte Partie des Dens ca. 2.-mal des Mucro. Alle meine Exemplare haben fast keinen Körperhaarkleid. Es muss an sich arm entwickelt sein. Die Beschuppung ist sehr hyalin und klein, viel kleiner als bei der bis jetzt mir bekannten *Lepidocyrtus* Arten.

Co-typus: 5 Expl. aus der Asibikigô-Höhle in Takarazima (26. V 1953).

Anmerkung: Nach der Körperfarbe ist die Form der aus Java beschriebenen *Lepidocyrtinus taeniatus* E. Handschin gar täuschend ähnlich. Es fehlt nur noch der Mittelquerband des Abd. IV und die Längsverband am hinteren Tibiotarsus. Da, aber, die Form morphologisch durch ungeringelten Ant. IV, distal geschobenen AZ der Klaue und endlich durch mit einem Gelenk versehenen hinteren Tibiotarsen von der Beschreibung obiger Art abweicht, habe ich sie wie eine neue Art angemerkt. Falls das Gelenkstruktur auch bei der Javanischen Form zustande kommt, so wäre eine neue Gattung für die Art nötig.

19. *Corynothryx sinensis* (Denis)

1 Expl. Takarazima (26. V 1953).

20. *Tomocerus kawamurai* Yosii f. *depicta* f. n.

(Abb. 8, A, B)

Die Form weicht von der Hauptart nur durch das Fehlen der Randzeichnung des Thorax. Die Tibiotarsen sind dagegen in schön rotvioletter Farbe.

Co-typus: 12 Expl. Takarazima, Tokara (8. VI 1953).

Anmerkung: Beim Untersuchen dieser Form merkte ich den BZ des Mucro mit einem Eckzahn begleitet ist. Durch genauer Betrachtung mit der Hoffnung ob die Charakter einen Artmerkmal darstellen könne, konnte ich nunmehr feststellen, dass

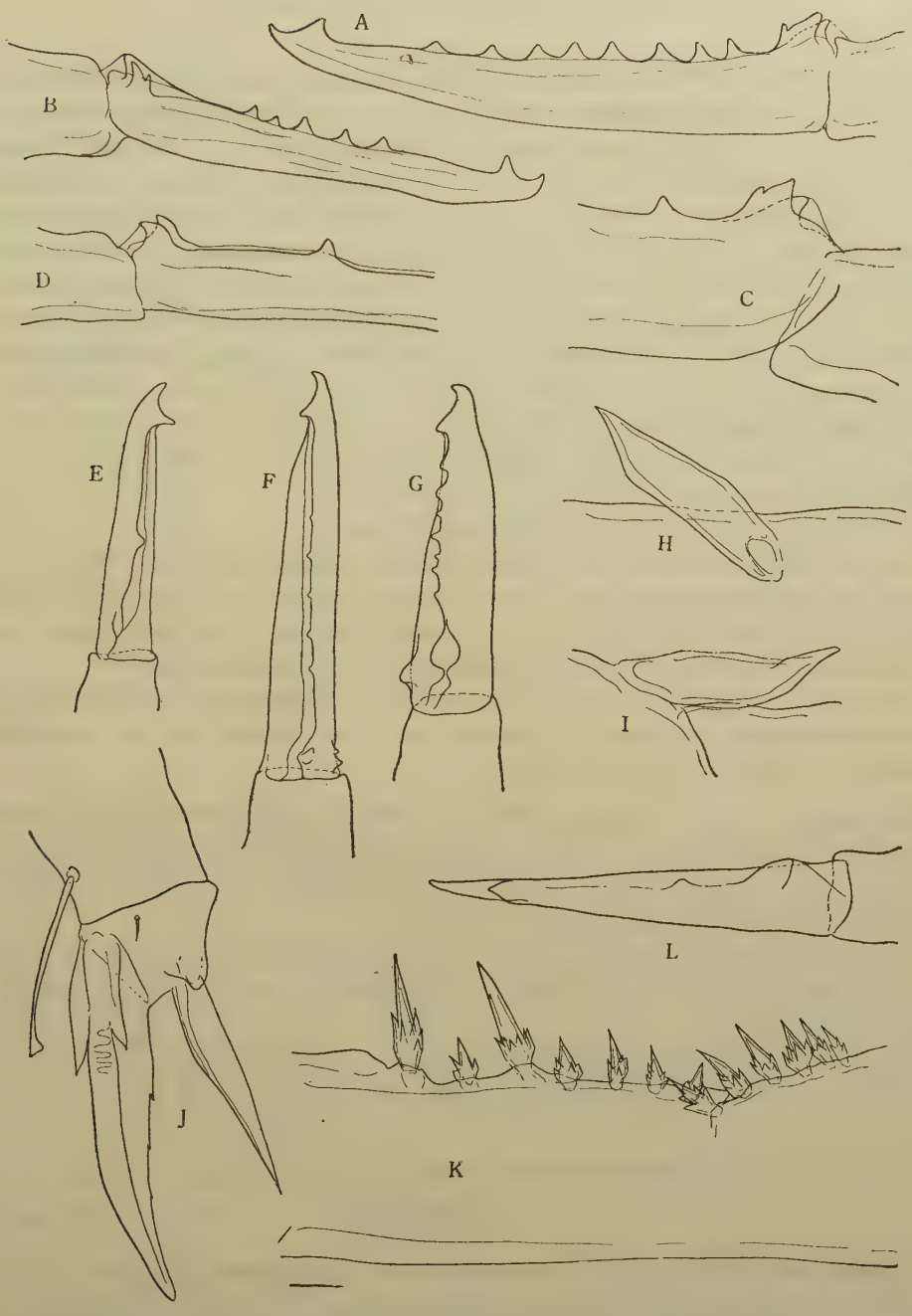

Abb. 8.

A, B: Mucro von *Tomocerus kawamurai* Yosii, f. *depicta* f. n. aus Tokara, C: Mucro von *T. minor* Lubbock aus Woods Hole, U.S.A. D: Mucro von *Tom. minutus* Tbg. aus Kyoto, E: Mucro von *Monodontocerus modificatus* g. n., sp. n. aus Tokara, F: Mucro von *Tom. kawamurai* Yosii aus Kyoto, G: Mucro von *Pogonognathellus flavescens* (Tbg.) aus Ozé, Japan, H, I: Schuppenartiges Anhang an der dentalen Tuberkel von *Pogonognathellus flavescens* (Tbg.) aus Ozé, J: Mittelklaue von *Monod. modificatus* g. n., sp. n. K: Dentaldornen von *Mon. modificatus* g. n., sp. n. L: Mucro von *Mon. modificatus* g. n., sp. n. (J, K, L: aus Tokara).

das Bild auf keinem Fall teratologisch sondern normales, konstantes Struktur ist. Ferner konnte ich das gleiche Bild von der bis jetzt aus Japan bekannten folgenden Arten feststellen: *Tomocerus kawamurai, kinoshitai, asahinai.* Sogar *Tomocerus minor* Lubbock (aus Woods Hole, U. S. A. Prof. Taku Komai leg.) (Abb. 8, C) zeigt das entsprichende Bild. In der Literatur fand ich solches Bild nur bei *Tom. bidenticulatus, jeanneli* Bonet (1934. Arch. Zool. exp. gen. 76 : 363) was deutlich auf dem stark modifizierten BZ einen Eckzahn trägt. Tomoceriden, die nicht mit dieser Struktur bestattet sind, sind folgende: *Pogonognathus flavescens* (Tullberg), *Tritomurus* spp. und *Tom. minutus* (Tullb.) (Abb. 8, D) Das letzte Fall scheint mir sehr bedeutungsvoll, denn man somit die Gattung *Tomocerus* zu zwei Untergattungen verteilen kann.

Untergattung *Eutomocerus m.*

Subgenotypische Art: *Tomocerus minor* Lubbock

Untergattung *Tomocerina m.*

Subgenotypische Art: *Tomocerus minutus* Tullberg

Es sei hinzufügen, dass das Struktur auch bei einem kleinen jugendlichen Exemplar von *Tom. kawamurai* deutlich zum Vorschein kommt. Im Japan gibt es noch eine andere Art, bei der die im Frage kommenden äusseren BZ der Mucro ganz und gar gefehlt ist. Ich nenne sie wie *Monodontocerus* g. n. (Abb. 8, E, J–L)

Wenn man den Mucro von drei Tomoceridenformen, *Eutomocerus, Pogonognathellus,* und *Monodontocerus* vergleicht, so bekommt man den Schluss dass sie folgendermassen von einander zu trennen sind.

1. *Eutomocerus*—Von dem Antap. Z. zum BZ verläuft bei der dorsalen Ansicht zwei parallel laufende Lamelle. Eine, die an der Aussenseite sich legende, ist mit IZ versehen und endet zu BZ während die andere ohne Bezähnelung bis zum dentalen Ende des Mucro verläuft. (Abb. 8, F)
2. *Pogonognathellus** Es fehlt die innere Lamelle des Mucro, weil man nur noch eine Lamelle mit IZ auf der dorsalen Seite bemerken kann, welche bis zum BZ verläuft. (Abb. 8, G)
3. *Monodontocerus*—Es finden sich zwei Lamellen. Die Ausenlamelle ist mit IZ bewaffnet. Aber beide Lamelle enden am BZ des Mucro. (Abb. 8, E)

21. *Monodontocerus modificatus* g. n., sp. n.

(Abb. 8, E, J–L)

Körperlänge ca. 3.5 mm. Im Leben bleigrau bis grauschwarz mit reichlich vor-

* Die Gattung *Pogonognathellus* Paclt ist, neben der bekannten Charakter des Maxillenkopfes, durch die Mucronalen Beschaffenheit und auch durch Basalstück des Dens gut zu unterscheiden. Das Basalstück ist bei *Eutomocerus, Tomocerina* und *Monodontocerus* spurlos, während es bei dieser Gattung mit einem deutlichen, hyalinen, spindelförmig zugespitzten, schuppenähnlichen Anhang (Abb. 8, G) bewaffnet ist (cf. Folsom, J. W. 1931, U. S. Nat. Mus. 46: Pl. 40. 2, 4, 6, 8.)

handenen Schuppen. Grundfarbe weisslich. Kopf und Thorax kann leicht braunisch sein. Antennen von der Mitte distal leicht violett gefärbt. Vorderrand des Th. ist dunkel besäumt. Alle Extremitäten sind blass. Ant./K. wie 2.3. Ant. III/IV wie 4.8. Augen schwarz, gut pigmentiert und mit 6+6 Ocellen. Maxillenkopf ohne ziegenbartförmiges Anhang. Die in allen Beinen gleich geformte Klaue ist mit einem paarigen Pseudonychia, die die Mitte der Klaue erreichen und mit einem auffallenden IZ. Dazu können noch 4 winzige Distalzähne vorhanden Empodialanhang ist schmal lanzettlich und mit einem starken IZ bewaffnet. Das schwach entwickeltes KH ist aus einem relativ dünnen Haarschaft und nur leicht verbreiter Spitze. Furca ca. 2/3 des Rumpfes. Man./De./Mu. wie 4.2 : 8.8 : 1.0. Man. ohne Ventralborsten aber mit Seitenborsten. Dentaldornen wie 5–3/2–5, I, 3–1, I, von denen die distale Reihe von I, 1–3, I immer konstant ist. Jeder Dorn ist zusammengesetzt mit mehreren winzigen Nebendornen. Mucro ist mit einem Ap. Antap. und einem BZ. IZ variieren sich von 1 bis 4. Mu/K3 wie 3.6.

Co-typus: 5 Expl. aus Kiku-no-Iwaya Höhle bei Kasiwagi, Kreis Nara (28. IV 1952 R. Yosii et S. Uéno).

Weitere Fundorte: Verschiedene Höhlen Japans aus der Kreise wie Nara, Kyoto, Tokusima, Kagawa, Kôti, Ehimé, Oita, Kumamoto und Kagosima. 10 Expl. sind aus der Höhle von Takarazima erbeutet. (26. V 1953, S. Uéno).

Gattung *Lepidosira* Schött

Körpergestalt entomobryid. Antennen 4-gliedrig. Ant. IV andeutungsweise geringelt. Endkolben undeutlich. Augen 8+8. Klaue gut entwickelt und mit einem paarigen, gut entwickelten PZ und auffallend grossen LZ (paarig) und DZ (einzahl). EA 1 ist oft am Aussenrande stark serriert. Dentale Tuberkel wening differenziert. Dens distal geringelt. Mucro zweizähnig und mit Basaldorn. Körperhaarkleid gut entwickelt. Beschuppung dicht. Antennen bis Ant. III, die Beine bis zum Femur und die Furka bis zum Dentes dicht beschuppt. Die Schuppen sind grob gestrichen wie bei der Gattung *Willowsia* (=*Sira*) und meistens braun gefärbt. Solche, die auf der dorsalen Seite des Rumpfes sich befindlichen sind rundlich, im Gegensatz zu der mehr spindelförmigen Schuppen der anderen Teile der Körpers. Besonders verlängert sind die Schuppen auf der ventralen Seite des Dentes. Die Gattung ist von *Willowsia* (=*Sira*) durch beschuppten Dentes und von *Pseudosira* (=*Mesira*) durch zweizähnigem Mucro scharf zu unterscheiden.

Eine Anzahl von Arten, die in der erwähnten Kategorien fallen, sind aus Ostasien und Australien unter der Gattung *Pseudosira, Mesira, Lepidosira, Sira, Lepidocyrtus* etc. beschrieben. Bei der Übersicht alter Literaturen habe ich folgenden ostasiatischen Arten* zum Mitglied der Gattung anerkannt und sie in der nachfolgenden

* Die Stellung von *Mesira inermodentes* H. Uchida aus Micronesia ist wegen stark geringelten Ant. III und IV problematisch.

Tabelle zu einzelner Arten zu unterscheiden versucht.

1. *Mesira gigantea* Börner 1909—Japan
2. *Mesira calolepis* Börner 1913, Handschin 1925—Java
3. *Mesira javana* Börner 1913—Java
4. *Lepidocyrtus anstralicus* Schött, 1917, Womersley 1937—Neu Guinea
5. *Lepidocyrtus pictus* Schäffer, 1899, Womersley 1937—Neu Guinea
6. *Sira gibbosa* Denis 1924—Japan
7. *Lepidosira montana* Schött—Borneo (Syn. von *L. calolepis* Bö.)
8. *Sira nilghiri* Denis, 1936, 1948—India und Indochina

1. Antennen blass—(calolepis Gruppe) 2
   Antennen gebändert—(gigantea Gruppe) 4
2. Die Beine sind von der Coxen bis zum Femur gleichmässig pigmentiert ..... *L. gibbosa* (Denis)
   Alle Beine sind entweder blass oder gebändert 3
3. Abd. IV blass oder nicht viel gefleckt ..... *L. calolepis* (Bö.)
   Abd. IV an beider Seite mit auffallender Längsbinde ..... *L. australica* (Schött)
4. Auf dem Kopf eine Längsbinde an beider Seite 5
   Nur einzelner Fleck um das Ommenfeld ..... *L. nilghiri* (Denis)
5. DZ und auch die LZ der Klaue klein ..... *L. javana* (Bö.)
   DZ der Klaue so gross wie bei anderer Arten der Gattung ... *L. gigantea* (Bö.)

22. *Lepidosira nilghiri* (Denis)

(Abb. 7, E–I)

Sira nil. Denis 1936. Mem. Connecticut Acad. Art. Sci. **10**, Art. XV—Denis, 1948. Notes d'Entom. Chinoise XII.

Zu der Beschreibung Denis' sei folgendes ergänzt. Körperlänge bis 4.8 mm. Grundfarbe des Körpers weisslich. Schwarzblaue Punkte verteilen sich sehr variabel, aber das reichlichst pigmentierte Exemplar trägt keine Längsbinde auf dem Kopf. Vielmehr gibt es einige Flecke um das Ommenfeld. Antennen am Ant. I, II und III quer gefleckt. Ant. IV ist diffus pigmentiert und mit leichter Andeutung der Ringelung versehen. Endkolben ist sehr undeutlich. Körperschuppen und ihre Verteilung auf dem Körper typisch für die Gattung. An der Klaue ist LZ so gross wie Pr. Z. zu dem 2 winzigen Dis. Z. nahe an der Spitze vorhanden. Ein Dors. Z. ist klein aber sehr deutlich. KH/K am B3 ca. 1.0. K/EA am B3 ca. 1.3. EA ist lanzettlich zugespitzt. Nur EA 1 ist am Aussenrand sägeartig incisiert. Gegenborste am B3 vorhanden, die so lang wie KH ist. Die gut ausgebildeter Furka hat D/Man. wie 1.0. Basaltuberkel des Dens ist ein gut chitinisierter Wulst, aber die darauf angewachsene Haare sind nicht besonders differenziert. Dens stark geringelt und am Ende plötzlich glatt werdend. Dentale Schuppen sehr zahlreich vortretend. Sie sind sehr verlängert und grob längsgestrichen.

Fundort: Nakanosima (7 Expl. 5. VI 1953).

Anmerkung: Die bisher aus Himalaya und Indochina bekannte Art ist aus Tokara-Inselnerschienen. Die grosse Farbenvariation des Körpers ist so regellos wie man sie nicht zu einzelner Forma unterteilen kann. Aus dem Hauptinsel Japans, habe ich schon das Hervortreten von zwei Gattungsgenossen: *Lep. gigantea* (Bö.) und *Lep. gibbosa* (Denis) bestätigt.

23. *Cyphoderus* sp.

Syn. *Cyphoderus albinus* (nec Nicolet!) H. Uchida 1944.

Eine freilebende (?) *Cyphoderus*-Art, die der Delam.-Debouttéville'schen "*bidenticulati*" angehört. Vermutlich stellt sie eine neue Art dar, die der aus Mittelamerika berichteten *Cy. inaequalis* Folsom 1927 sehr nahe steht. Die von Uchida aus Mikronesia berichtete dass *Cy. albinus* (Nic.) ist, nach seiner Figur zu beurteilen, mit dieser Form identisch.

Fundorte: Nakanosima (10 Expl. 5. VI 1953)—Takara-zima (4 Expl. 26. V 1953).

24. *Akaboshia matsudoensis* Kinoshita

Fundort: Nakanosima (1 Expl. 8. VI 1953).

25. *Arrhopalites binoculatus* Börner

Fundort: Asibikigô no Iwaya, Takara-zima (2 Expl. 26. V 1953).

Gattung *Ptenothryx* Börner

In meiner früheren Arbeit über die Morphologie der Gattung (Yosii, R. 1954 Sci. Res. Ozegahara Moor, Tokyo) habe ich auf die Wichtigkeit der dentalen Fiederborsten zu ihrer Systematik angewiesen und zu einiger japanischen Arten neuen Diagnosen gegeben. Inzwischen arbeitete H. Uchida (1953. Ann. Zool. Jap. 26:1) auf gleicher Thema und formulierte die Chaetotaxie des Dentes. Ich stimme ihrem Schlusswort ganz bei, wenn er schreibt dass, "*Ptenothryx* seems to be considered as an unstable genus, whose species are now in process of evolution or specialization." Für die Benennung und Diagnotisierung der dentalen Borsten, aber, bin ich anderer Meinung und bringe meine eigene Ergebnisse der dentalen Chaetotaxie folgendermassen zum Ausdruck:

Wenn man eine Furka von *Ptenothryx* vom oben ansieht, so merkt man folgenden 3 Reihen von Borsten: (Abb. 9, A, B, C).

1. Dorsale Reihe (D–): Sie besteht aus 4 nackten, langen und aufrechtstehenden Borsten und variiert kaum nach der Arten.

2. Aussenreihe (A-): Ectolaterale Reihe (Börner, C. 1909, Yosii, R. 1954), C-Reine (Uchida, H. 1953). Hier sind insgesammt 10 Borsten vorhanden, die ich von der distalen nach der proximalen Richtung A-1 A-10 bezeichnen darf. A-1 steht nicht vor, sondern neben dem A-2 und deswegen von der bisherigen Autoren nicht zu einer gleichen Reihe angezählt. (E-Reihe von H. Uchida und "Neben der ectolateralen Reihe stehende Borste" von C. Börner). A-1 bis A-8 sind, in allen mir bis jetzt bekannten japanischen Arten gefiedert bzw. verdickt, während AL-9 und AL-10 immer glatt sind.
3. Innenreihe (I-): Im Prinzip ist diese Reihe kaum anders als A-Reihe. Hier ist auch die I-1 und I-2 nebeneinanderstehend und I-9 und I-10 glatt. Im Grad der Befiederung einzelner Borsten, kann aber leichtes Unterschied vorkommen. So ist z. B. in *Pt. corynephora* Börner, A-1 kaum gefiedert während I-1 deutlich gefiedert ist.

Wenn die Furka umgeschlagen wird, so sieht man hier auch drei Reihen.

4. Ventrale Reihe (V-): Hier sind immer 5 Borsten vorhanden. V-1 bis V-4 legen sich an der distalen Ende, sind dick und kurz und an der Basis gebogen dass sie zum Dens anliegend verläuft. V-5 ist eine glatte Borste, die nahe der dentalen Basis liegt.
5. Subventralen Reihen (aV- und iV-): An beider Seite des V-1 bis V-4 sind je eine Reihe von Borsten, die ihr gleich geformt sind. Die an der Aussenseite gelegenen (aV-) besteh aus 2 und die andere (iV-) aus nur 1.

Diese Chaetotaxie ist, solange ich bis jetzt festgestellt habe, sehr konstant und kaum variierbar. Unterschied nach der Arten äussert sich u. A. auf die Gefiederung der A- und I-Reihe, die meistens gleichartig sich modifizieren. Die von H. Uchida (1953) beschriebene Abweichungen der Chaetotaxie in *Pt. lactea*, *tricycla*, *ryoheii* bedürfen die Bestätigung.

26. *Ptenothrix tsutsuii* sp. n.

(Abb. 9, D-J)

Körperlänge bis 2.4 mm. Farbe im allgemein schwarzblau. Die Antennen und Abdomen sind uniform tief gefärbt. Der kopf ist zwischen beider Antennenbasis und weiter unten an der Wange mit brauner Flecke. Oberhalb des Clypeus median und an beider Seite mit wabiger Fleckenbildung. Halsteil und die ventrale Seite das Rumpfes blasser. Die Beine, Ventraltubus sowie die Furka geschwärzt mit Ausnahme der tibiotarsalen und mucronalen Ende, die verblasst sind. Ant. Verh. wie 1 : 6 : 7.5 : 1.4. Augen 8+8. Scheitelborsten glatt. Die Klaue ist mit je 2 IZ. Dorsale Pseudonychia ist mässig entwickelt. EA normal für die Gattung. Ein innerer Eckzahn ist vorhanden. K/EA am K1 gleich lang und am K3 wie 5/3. Fadenanhang des EA so lang wie die Klaue und am Ende leicht verbreitert (ob immer?). Setae

plumosae auf dem hinteren Tibiotarsus sind, im Vergleich zu *Pt. corynephora* mehr spitzig endigend und weniger und schwächer gefiedert. De/Mu wie 3.5. Die Dentalborstenreihe wie oben erwähnt. Im Gegensatz zu *Pt. corynephora*, ist glatte A–1 und

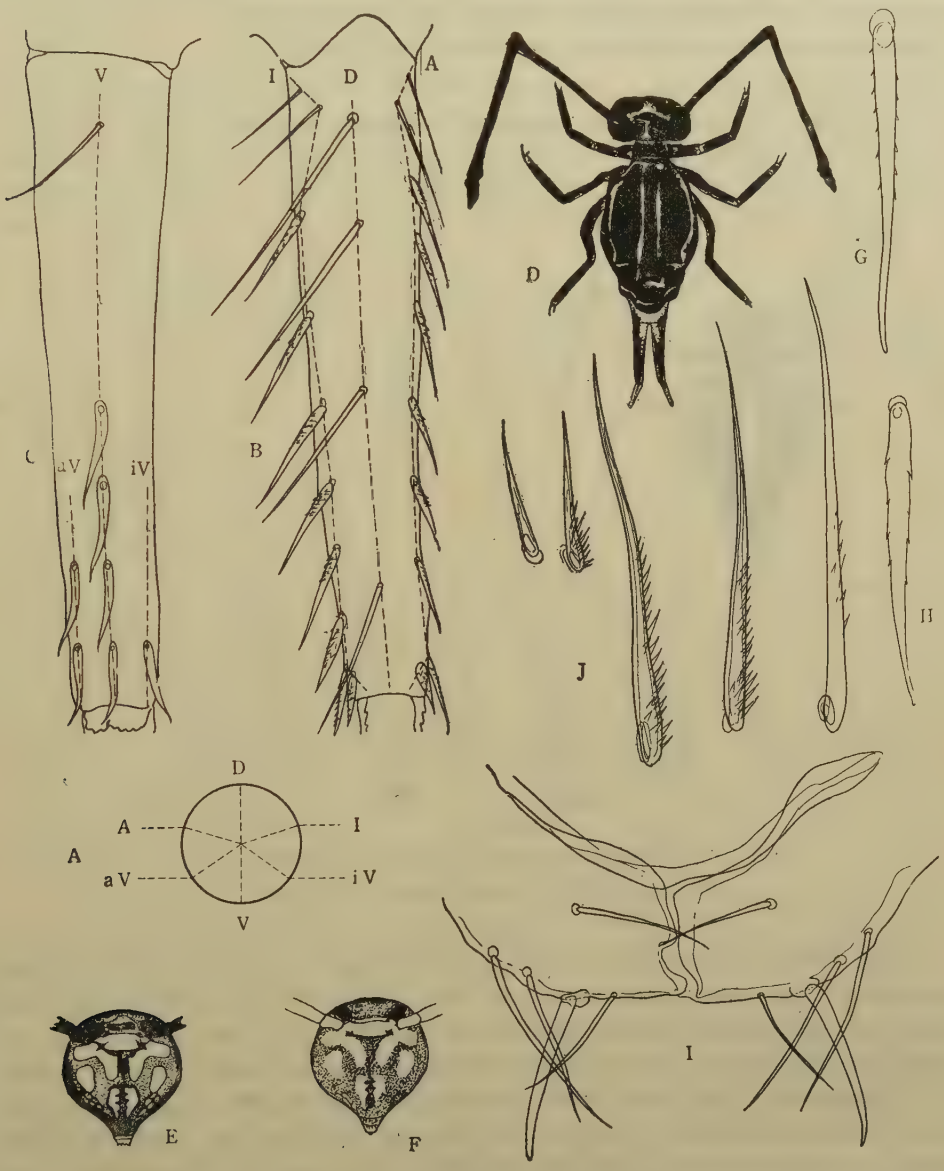

Abb. 9. *Ptenothryx tsutsuii* sp. n.

A, B. C: Halbschematisches Bild des Dens: A: Querschnitt, B: Dorsalansicht, C: Ventralansicht. D: Habitusbild, E: Vorderseite des Kopfes, F: Do, G: Tibiale Fiederborste, H: Do, I: Anallappen mit App. Anal. J: Borsten der A-Reihe (Al, A2, A3, A4, A8).

leicht gefiederte A-2 fast gleich lang und ca. 1/3 von A3, was das entscheidende morphologische Merkmal der vorliegenden Art darstellt. Mucro an beider Seite fein gezähnelt und mit grosser Einkerburg am Ende. Dorsale Borsten des grossen Abdominalabschnitts normal. Appendices Anales ist leicht länger und dicker als die benachbarten Analborsten, die auch so glatt sind wie sie selbst.

Co-typus: 4 Exemplare aus Nakanosima (5. VI 1953).

27. *Ptenothryx corynephora* Börner, f. *shibanaii* f. n.

(Abb. 10)

Abb. 10. *Ptenothryx corynephora* Börner, f. *shibanaii* f. n.
A: Gesamtbild, B: Dentale Borsten von A1-A10.

In der Körpergestalt gleich wie die Hauptform und in der Körperfarbe von ihr verschieden. Das ganze Kopf ist bis an den Mundrand blau violett. Antennen farblos, aber mit blauschwarzer Verbände an der Mitte des Ant. II und III. Die Gelenke zwischen Ant. II/III und III/IV sind auch leicht geschwärzt. Ant. IV ist nur diffus pigmentiert. Auf dem grossen Rumpfabschnitt, der wie Kopf uniform in gleicher Farbe gezeichnet ist, ist an der dorsalen Mittellinie mit einem weisslich gelben Längestrich versehen, der von dem Hals bis kurz vor Abd. V durchläuft. Ein paariges, gleichfärbiges Pünktchen, das links und rechts neben der dorsalen Tuberkel sich befindet ist manchmal deutlich, aber auch oft mit dem Hauptstrich zu einen Kreuz verbunden sein kann. Anogenitalsegment ist vorne mit einem weissen Strich

und seitlich mit einem blassen Punkt. Von der Anallappen sind die obere geschwärzt und die beiden lateralen farblos.

Auf der ventralen Seite ist das Tier blasser gefärbt. Alle Beine sind an der Coxa tief gefärbt, aber von Trochanter an, distal vollkommen weiss mit Ausnahme der Femur, auf welcher, ein kleiner, violetter Fleck vorhanden ist. Ventraltubus farblos. Die Furka ist nur am Manubrium leicht pigmentiert. Morphologisch weicht die Art nicht von dem Hauptform. Scheitelborste ist genau so dick, dolchförmig zugespitzt und mit leichten Längsstriche versehen. An der Klaue ist Pseudonychium mässig entwickelt. Fadenanhang des EA am Ende deutlich kugelig aufgeschwollen. Von der Fiederborsten des Dentes sind glatte A–1 und leicht gefiederte A–2 sehr klein. Appendices Anales wenig modifiziert von der Analborsten und ca. so lang wie die ihr nebenstehenden.

Co-typus: 6 Expl. aus Nakanosima (6. VI 1952).

Weiterer Fundort: Mt. Isizuti, Kreis Ehimé (3 Expl. 3. VI 1952, S. Shibanai).

MARINE INSECTS OF THE TOKARA ISLANDS

VII. NEW SPECIES AND NEW SUBSPECIES OF THE SUBFAMILY TRECHINAE (COLEOPTERA, HARPALIDAE)[1]

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With 7 Text-figures

The carabid-fauna of the Tokaras, a group of small islands which lie between the Islands of Yakushima and Amami-Ôshima, south-west of Kyushu, should be looked for with great interest from the zoögeographical point of view. It is remarkably different from that of any other part of Japan, even from that of the Island of Yakushima that is situated in a distance not exceeding 170 km north-east from Takarajima, southernmost one of the islands concerned. Moreover, there is a distinct difference between the carabid-faunae even within the Tokaras, that of the southern and that of the northern. In Nakanoshima, one of the northern islands, the Palaearctic elements seem to be dominant to a certain degree, while in Takarajima, one of the southern, the inhabitants are of quite Oriental. Many tropical species spread over Formosa to Takarajima, but do not extend to Nakanoshima. When the examples are taken up from the subfamily Trechinae, the northern limits of *Lymnastis pilosus* H. W. Bates, *Polyderis impressipennis* (Motschulsky) and *Eotachys euryodes* (H. W. Bates) are, so far as has been known to the writer, found in the Island of Takarajima. This is an important fact which resembles the distribution of several reptiles, such as *Typhlops braminus* (Daudin), *Liopeltis semicarinata fritzei* Maki and *Trimeresurus flavoviridis tokarensis* Nagai.

On the western coast of the Island of Nakanoshima, there have been found two marine species of Caraboidea, both belonging to the tribe Bembidiini of the subfamily Trechinae. They seem to be new to science. In this paper are described these marine forms together with conveniently two other new forms of the subfamily. The writer should describe here one more new species, *Eotachys troglophilus* S. Uéno (in litt.). However, the recent discoveries of this species in Kyushu and Shikoku has compelled him to revise the species, and the publication of its description will be adjourned until the species will be re-examined. The type-specimens of the new

1) Scientific Survey of the Tokara Islands, Report No. 21.

species and new subspecies described in this report are deposited in the collection of the present writer and of the Osaka Municipal Museum of Natural History.

The writer wishes to express his cordial thanks to Mr. Yoshitaka TSUTSUI, the director of the Osaka Municipal Museum of Natural History, who kindly gave the writer the opportunity to join the Tokara Expedition 1953 under his leadership. The study of the collection made during the Expedition was carried on in the Entomological Laboratory of Kyoto University under the supervision of Prof. Syunro UTIDA and was continuously encouraged by Prof. Takasi TOKIOKA, of the Seto Marine Biological Laboratory, one of the members of the Expedition. To these professors the writer's hearty thanks are due. Best gratitudes should also be expressed to Messrs. Akinobu HABU of the National Institute of Agricultural Sciences and Kazuyoshi KUROSA of Saéki City for their kind assistance in supplying useful material for comparison.

Trechoblemus microphthalmus S. UÉNO, sp. nov.

Trechoblemus microphthalmus S. UÉNO, 1953 (in litt.), Shin Konchû, Tokyo, **6** (11) : 43.

Length : 3.35–3.55 mm (from front margin of clypeus to anal end).

Brachypterous. Body elongate and depressed ; pubescent ; all the setae so remarkably long as those in the cavernicolous species. Pale reddish brown to reddish brown, head rather darker ; dull-shiny, elytra somewhat opalescent ; as the elytra are translucent, a vague longitudinal dark marking is seen through each of them according to individuals ; appendages paler.

Head large, with distinct frontal furrows ; eyes small, hardly prominent ; genae remarkable, longer than eyes and convex ; neck wide ; surface sparsely pubescent, microsculpture consisted of well marked reticulation ; antennae stout, subfiliform, reaching basal two-fifths of elytra, with apical segments a little oval.

Pronotum transverse-subcordate, moderately convex, about 1.25 times wider than head, wider than long in a same proportion, widest at about apical one-fourth ; base truncated, slightly narrower than apex which is slightly but widely emerginate ; sides gently rounded in front, weakly sinuate before hind angles which are rectangular and each with a postangular seta, front angles rounded ; median line deep ; front transverse impression shallow but evident ; basal transverse impression deep, with a longitudinal narrow pore on each side of median line, and merging on each side into a large and deep basal fovea ; surface finely and rather closely punctate, mesh-like microsculpture present though indistinct.

Elytra elongate with nearly parallel sides, moderately convex but flat on disk, fully 1.3 times wider than pronotum, about 1.8 times longer than wide (the ratio somewhat variable according to individuals) ; shoulders distinct ; punctate-striate, striae shallow especially on both sides though clear, striae 1 and 2 becoming deeper towards apex, scutellar striole present, apical striole deep ; intervals slightly convex near suture, flat on the sides, with irregular rows of punctures ; stria 3 with two dorsal

pores placed at about basal one-fifth and a little behind middle respectively, preapical pore close to apex and adjoining stria 2; microsculpture consisted of transverse lines but indistinct.

Legs stout; protibiae not externally grooved.

Male gential organ small and moderately chitinized. Aedeagus elongate, moderately arcuate, so swollen out before apex that the ventral side is evidently convex; apex somewhat prolonged into a blunt point; sagittal aileron well developed. Inner sac armed with a large spatulate copulatory piece which is covered with numerous scales and is symmetrically placed in the sac with the guttered face ventrally, apical part of this piece membraneous. Styles wide, left style a little longer than right, each provided with four setae at apex.

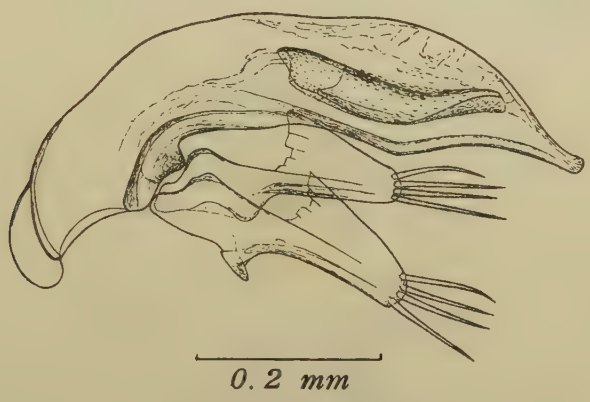


Fig. 1. Male genital organ of *Trechoblemus microphthalmus* S. UÉNO, sp. nov.; left lateral view.

Holotype: ♂, allotype: ♀, paratypes: 1♂, 2♀♀ (29, 30–V–1953, collected by S. UÉNO).

Type-locality: Ôiké, on the island of Takarajima, one of the Tokara Islands.

The present new species is a close relative of the European *T. micros* (HERBST), but is easily distinguished from the latter by its smaller size of body, the smaller eyes, and the quite different structure of the male genital organ.

Ôiké is a small marsh situated in a hollowed depression between the dune and the scrubby hill on the small island of Takarajima. After heavy rain, however, the marsh becomes full-filled with water forming a lake suddenly. On May 27th and 28th, 1953, the island was attacked by a typhoon and the downpour caused flood in Ôiké. All the inhabitants of the marsh were so driven out from their shelters that let the writer to be able to obtain so many interesting carabids as to include many genera and species which were all newly added to the Japanese fauna. The present new species was also found at that opportunity.

Armatocillenus (*Corallicillenus* subgen. nov.) *tsutsuii* S. UÉNO, sp. nov.

Length: 3.3–3.9 mm (from front margin of clypeus to anal end).

Body elongate; surface impunctate and glabrous; metathoracic membraneous wings rudimentary. Reddish brown, depigmented and dull-shiny; palpi, antennal segments 1–3 and legs light reddish brown.

Head large and wide, with frontal furrows which are deep, wide, parallel and extending onto clypeus; eyes rather small, a little prominent and coarsely faceted, much longer than genae which are slightly convex; supraorbital carinae obtuse though prominent; neck very wide; labrum very transverse; microsculpture consisted of isodiametric meshes which are rather slight on front and vertex; mandibles elongate, hooked at apices; antennae stout, extending a little beyond basal one-fourth of elytra, segments 8–10 distinctly ovate, forming the submoniliform apical part.

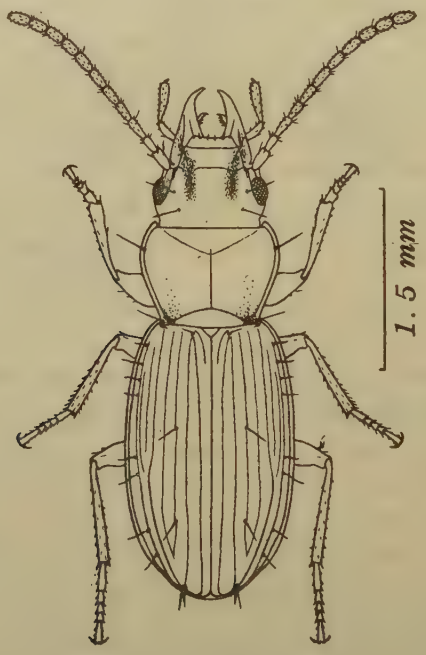


Fig. 2. *Armatocillenus tsutsuii* S. UÉNO, sp. nov., ♂.

Pronotum transverse sub-cordate, contracted behind, moderately convex; about 1.2 times wider than head, 1.30–1.35 times wider than long according to individuals, widest at about three-fourths from base; sides sharply reflexed throughout, gently rounded in front and very slightly sinuate behind; side-gutter evenly deep along the whole length of side-border, with one lateral seta at apical one-fifth or more in front according to individuals; apex slightly but widely emarginate; base distinctly narrower than apex, about seven-eighths as wide as the latter, produced at the median part

and emarginate on each side just inside hind angles, which are consequently projected backwards and sharp; front angles well projected forwards and a little blunt at the tip; median line distinct, extending beyond neither front transverse impression nor basal sulcus; front transverse impression slight, with several vague punctures; basal transverse sulcus continuous, arcuate, evenly deep and merging on each side into basal fovea which is small but deep; surface somewhat depressed longitudinally on each side in front of basal sulcus and inside side-gutter, forming posteriorly a very obtuse ridge between this depression and side-gutter; microsculpture formed by isodiametric meshes but rather faint on disk.

Elytra elongate, moderately convex, fully 1.2 times wider than pronotum, about 1.65 times longer than wide (the ratio somewhat variable according to individuals); shoulders effaced; sides slightly rounded at middle and slightly emarginate before

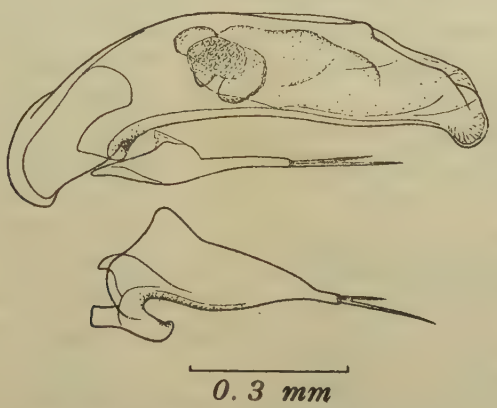


Fig. 3. Male genital organ of *Armatocillenus tsutsuii* S. UÉNO, sp. nov.; left lateral view, with left style removed.

apices; striae deep, impunctate, stria 5 deepening behind middle and merging into apical striole; intervals a little convex, interval 5 widening out behind middle and forming outside a remarkable apical carina; interval 3 with two dorsal pores nearly adjoining stria 3, placed at about two-fifths and three-fourths from base respectively; nearly isodiametric microsculpture well developed throughout.

Legs short and stout.

Male genital organ similar in structure to that of *Armatocillenus aestuarii*. Aedeagus relatively a little more elongate and more arcuate, with apex much strongly bent; ventral side a little convex before apex. Right style comparatively long and with long apical prolongation; each style furnished with two apical setae as in *A. aestuarii*.

Holotype: ♂ (Amadomari, 6-VI-1953, collected by S. UÉNO); allotype: ♀ (Yoriki, 4-VI-1953, by S. UÉNO).

Paratypes: 14♂♂, 10♀♀ (Yoriki, 4–VI–1953, by S. UÉNO); 8♂♂, 5♀♀ (Amadomari, 6–VI–1953, by S. UÉNO); 2♂♂, 2♀♀ (Amadomari, 9–VI–1953, by S. UÉNO).

Type-localities: Yoriki and Amadomari, on the island of Nakanoshima, one of the Tokaras.

This remarkable new species inhabits the coral reef on the western coast of Nakanoshima. Its habitat is so far below the high-water mark that the species is submerged in water for long hours a day. At maximum low tide, it is found under stones of fragments of coral, coexisting with several species of Staphylinids (all new to science), *Petrolisthes* spp., *Polycheira rufescens* (BRANDT), *Ophiocoma scolopendrina* (LAMARCK), and other invertebrate animals.

Several individuals of callows and two individuals of different stages of larvae were also obtained in the same habitat. These discoveries suggest that pupation of this species takes place late in spring or early in summer. The larva seems to resemble that of *A. yokohamae*, but, as material for comparison is lacking, here is given only an illustration of a specimen in a mature stage, reserving the description.

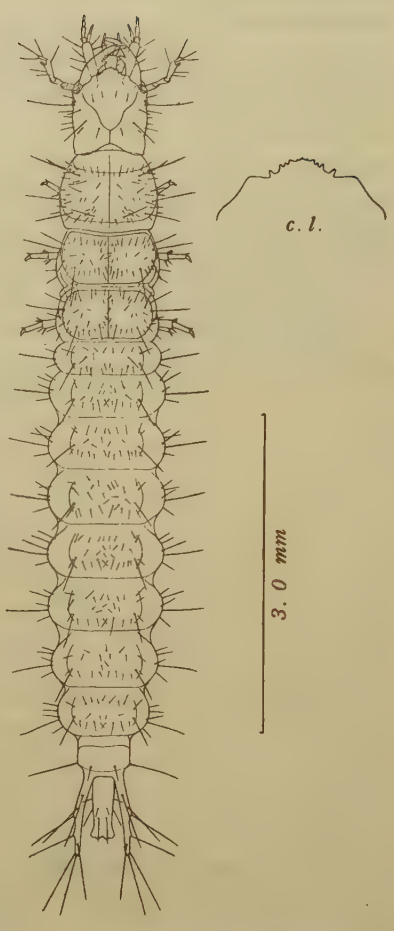


Fig. 4. Larva of *Armatocillenus tsutsuii*; *c.l.*: clypeal lobe.

Peryphus (s. str.) *semiluitus* (H. W. BATES)

Bembidium (*Peryphus*) *semiluitum* H. W. BATES, 1883, Trans. Ent. Soc. London, 275; type-locality: Honjo.

Bembidion (*Peryphus*) *semiluitum*, NETOLITZKY, 1942, Koleopt. Rdsch., 28: 46; 1943, loc. cit., 29: 36.

P. semiluitus has long been neglected though it is distributed over the Pacific coast of southern Japan. The late Dr. NETOLITZKY may be a sole entomologist who has given an account of this interesting species. His brief notes, however, seem to become insufficient to recognize the species, since a new subspecies has been discovered

by the present writer. It appears to be best to give its detailed redescription in this occasion.

Length: 4.5–5.0 mm (from front margin of clypeus to anal end).

Winged. Shiny brownish black with strong aeneous tinge, ventral surface brown to dark brown; elytra dark brown, with olivaceous tinge, and with the apical area widely dark yellowish brown though this light area does not form defined spot and sometimes vanished according to individuals; labrum and mandibles brown; antepenultimate segment of maxillary palpi, antennal segments 1–3 with basal half of segment 4, and legs flavous.

Head with fairly deep frontal furrows and moderately prominent supraorbital carinae; eyes prominent; genae very short; surface smooth, but several minute punctures present on the hind ends of frontal furrows; microsculpture absent on median areas but visible as reticulation in frontal furrows and on neck; antennae long, reaching basal one-third of elytra.

Pronotum subquadrate, convex, about 1.3 times wider than head, wider than long in a same proportion (a little wider in ♀ than in ♂), widest at about five-eighths from base which is obviously wider than apex and slightly arcuate, apex about seven-ninths as wide as base, slightly but widely emarginate; sides gently rounded in front and slightly sinuate behind, side-gutter distinct throughout along side-border; hind angles nearly rectangular, each with an obtuse carina, front angles narrowly rounded; median line evident, transverse impressions shallow, basal foveae large and deep; basal area finely and sparsely punctate; microsculpture consisted of transverse lines at the sides but completely vanished on disk.

Elytra oblong ovate, convex, about 1.4 times wider than pronotum, about 1.6 times longer than wide; sides oblique at shoulders and very slightly emarginate before apices; punctate-striate, striae shallow, becoming shallower towards the sides, stria 7 nearly obsolete though marked with a row of fine punctures, stria 1 entire, others disappearing behind, stria 8 deep throughout, apical striole rudimentary; intervals flat; interval 3 with two dorsal pores adjoining stria 3, placed at about two-sevenths and five-eighths from base respectively; humeral group of umbilicate pores four, ranged irregularly, fourth pore isolated; microsculpture formed by transverse lines.

Male genital organ well chitinized. Aedeagus rather elongate and arcuate, with right basal lobe produced; apex moderately bending to ventral side and narrowly rounded at the tip; a band of pubescence present at the proximal end of apical orifice. Copulatory pieces separated into four components: a dorsal whip-shaped piece which is suddenly twisted at the middle of inner sac from basal right to apical left, a bundle of fibres, placed at the right side of the basal part of dorsal whip, a reniform plate at the right basal side of the bundle of fibres, and an additional piece. Styles subequal in length, each provided with four apical setae.

Range: Honshu, Shikoku and Kyushu. Usually found under stones or refuses on the beaches of brackish water areas.

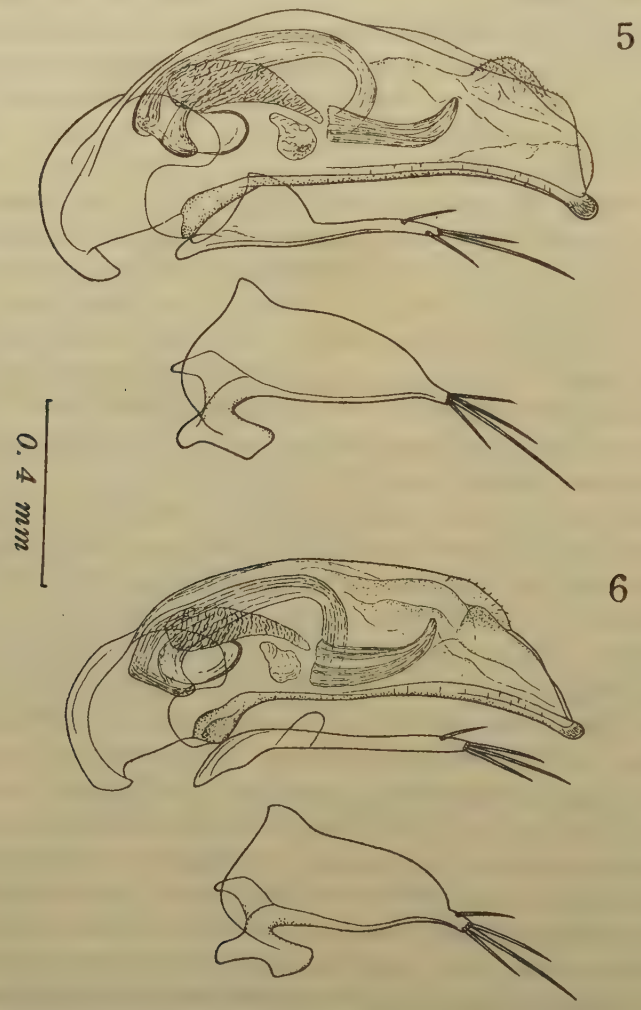
The writer has examined the specimens from the following localities:

Honshu: the Tonegawa River, by Toride, Ibaraki Pref.; the Edogawa River, by Gyôtoku, Chiba Pref.; the Arakawa River, by Horikiri, Tokyo; the Kanogawa River, Shizuoka Pref.; the Shin-Yodogawa River, by Jûsô, Osaka; Hamadera, Osaka Pref.

Shikoku: Kyûkô, Kôchi.

Kyushu: Saéki, Ôita Pref.; Nobéoka, Miyazaki Pref.

The male genital organ was examined in the specimens from Gyôtoku, the Shin-Yodogawa, Kyûkô and Saéki.



Figs. 5–6. Male genital organ, left lateral view, with left style removed.——5. *Peryphus semiluitus* H. W. BATES, of the Shin-Yodogawa River.——6. *P. semiluitus nakanoshimensis* S. UÉNO, subsp. nov., holotype.

Peryphus (s. str.) *semiluitus nakanoshimensis* S. UÉNO, subsp. nov.

This new subspecies may be distinguished from the original form by the following features:

Length: 4.5 mm (from front margin of clypeus to anal end).

Colour as in the dark individuals of the original form, with antennal segments 4–11 rather lighter; the light area on the apical part of elytra very small.

Head and pronotum less transverse and the sides of elytra less rounded especially before apex, appearing a slenderer body-form as a whole. Elytral striae obviously deeper with much coarser punctures; intervals a little more convex especially on disk.

Aedeagus shorter, with apical part gradually tapering towards apex which is more narrowly rounded and is less bending ventrally; pubescent area at the proximal end of apical orifice smaller and the pubscence itself sparser.

Holotype: ♂ (Amadomari, 8–VI–1953, collected by S. UÉNO); allotype: ♀ (Satomura, 25–V–1953, by S. UÉNO).

Type-localities: Amadomari and Satomura, on the island of Nakanoshima, one of the Tokaras.

The type-specimens were obtained under stones on the intertidal zone, where small brooks flowed into the sea.

Asaphidion (s. str.) *tenryuense kônoi* S. UÉNO, subsp. nov.

The present new subspecies may be discriminated from the original form by the following characteristics:

Length: 4.2 mm (from front margin of clypeus to anal end).

Pronotum a little more elongate, less narrower than head comparing with the original form, widest more in front and more suddenly contracted before the widest part; base much more strongly produced backwards, so that it is quite oblique on each side, forming an obtuse but distinct angle at middle.

Elytra shorter, a little wider in ♀ than in ♂, 1.65 times longer than wide (1.75 times longer than wide in the original form); striae nearly obsolete, only the trace of striae 1 and 2 perceptible on basal three-fifths, while in the original form, striae 1–5 or even 6 present at least on basal half.

Male genital organ of quite the same structure with that of the original. Aedeagus elongate, with apical part slightly bending ventrally; basal orifice large and opened to right face, with right basal lobe produced; ventral side very slightly convex at the middle; apex produced and widely rounded. Copulatory pieces complex, separated into the following components: a well chitinized large piece at the left lateral side, a small twisted piece and a bundle of fibres at the right of the large piece and a right dorsal piece. Styles subequal in length, each furnished with three setae at apex.

Holotype: ♂ (Takao, 8–VI–1953, collected by H. KÔNO); allotype: ♀ (Satomura, 12–VI–1953, by S. UÉNO).

Type-localities: Takao and Satomura, on the island of Nakanoshima, one of the Tokara Islands.

Asaphidion tenryuense (originally misread as *A. tenryuensis*)* was described based on a large female specimen collected at the Tenryûgawa River by Iijima-mura, Nagano Prefecture. The writer was able to examine this holotype-specimen through the courtesy of Mr. A. HABU. Though two male specimens collected by Mr. K. KUROSA

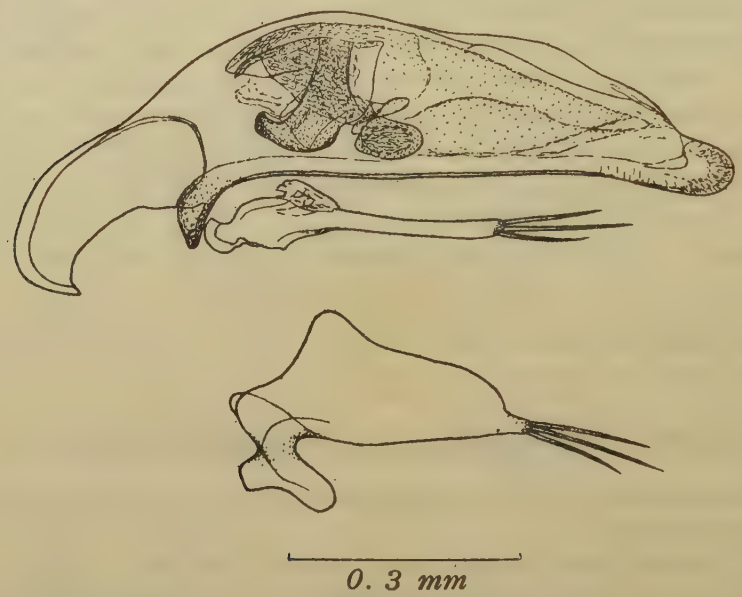


Fig. 7. Male genital organ of *Asaphidion tenryuense kônoi* S. UÉNO, subsp. nov., holotype; left lateral view, with left style removed.

at Sakasegawa, north-west of Osaka, on May 17th and 18th, 1940, are evidently smaller than the holotype, it seems that KUROSA's specimens are conspecific with *A. tenryuense*. The male genital organ of *A tenryuense tenryuense* s. str., compared in this paper with the present new subspecies, was examined in one of these specimens from Sakasegawa.

Both the type-specimens of *A. tenryuense kônoi* were obtained under barks in the forest, coexisting with *Peryphus morawitzi* (CSIKI).

* *Asaphidion tenryuensis* HABU, 1954, Bull. Nation. Inst. Agric. Sci., Tokyo, (C), 4: 288, fig. 6.

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